Can We Stop a Nuke?

Would We Know E.T. If We Met Him?

AIR&SPACE Smithsonian

SPECIAL EDITION Airshows 2007

The Snowbirds
9 Ways To Wow the Crowd

AVIATION'S OUTLAW PAST (P. 26)

WILL YOUR TOWN GET A SPACEPORT?

CAF 431 Air Demonstration Squadron

MAY 2007

For the first time since 1815,
Switzerland goes to war

How do you say enough is enough in German, French and Italian? Since the Swiss speak all three languages, that is exactly what our Swiss watchmakers are saying to the Chinese and the Japanese as the finest luxury watchmakers in the world have laid down the gauntlet against their Asian rivals. The result? A good war—A price war! The Swiss are usually a peaceful people but they want their watch business back. Stauer offers the impeccable Swiss-made certified diver's chronograph at **$297.00.** Originally, this watch was designed and engineered to be priced at $2,500 since that would normally be the competitive retail price for a Swiss diver's chronograph with these features, but that is not the Stauer way. We cut out the retailer's margin and poured the money into the split second movement, the rugged case and the sapphire crystal. Of course, the Swiss will never compromise on watch quality. This diver's timepiece has a sapphire crystal—the finest, hardest crystal available—a screw down back, and is **water resistant all the way down to 660 feet**—that's 20 atmospheres. The turning bezel lets you measure elapsed time, and the luminescent hands and numeral markings keep the time visible in low light and underwater situations. The accuracy of the Swiss made movement is tested and retested to be precise. The interior dials measure elapsed time down to 1/10th of a second. An extra long two year warranty on the movement is standard. Examine the form and function of the Deep Swiss to any comparable Rolex®, TAG Heuer®, or Breitling®.

If the Swiss had a navy, this would be their watch. Despite being surrounded by a world at war, Switzerland managed to maintain neutrality in both the first and second world wars. But when it comes to their beloved craft of building the world's finest timepieces, neutrality is out the window. A few Swiss watchmakers are still thinking that they can keep their prices in the stratosphere and get by on image alone. But at the end of the day, it's really only performance that counts. The Stauer Deep Swiss changes everything.

The Swiss do not rush production, however, so there are only 1,500 Deep Swiss watches available—and those took close to one year to produce.

The next production is at least 6 months off. Don't wait to join the fight. Of course, if the Deep Swiss does not exceed your expectations, we will be happy to take it back for a full refund of the purchase price within 30 days. Call and join the fight today!

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For centuries, if someone wanted a watch worthy of passing on to future generations, it had to come from Europe. Then, in 1842, a small American manufacturer of fine timepieces began to produce clocks and watches that rivaled those of the Europeans.

Since then, the expert watchmakers at E. Howard and Company have been known around the world for the accuracy and classic elegance of their timepieces. Now, they've developed the Continental Atomic Wristwatch blending quality craftsmanship, distinctive design, and atomic accuracy into one watch. It's destined to be in your family for years, and it's guaranteed to be accurate to within a billionth of a second.

Never set your watch again. The reason this watch is so accurate is because it gets its signal from the official U.S. Atomic Clock in Fort Collins, Colorado. The standard for time keeping throughout the U.S., the Atomic Clock uses sophisticated technology to measure the vibration of atoms, which is constant. For this reason, it is accurate to within a billionth of a second, and will take approximately 6 million years to lose a second! Until now, watches designed to receive the radio signal had to have plastic cases. Now, "America's Timekeeper" has created a high-quality analog watch in stainless steel style. The watch is designed so that it can still receive the signal– so you get traditional elegant styling with modern time-keeping accuracy. Once you've selected the proper time zone, you never have to touch it again. It automatically adjusts for Daylight Savings Time, 30-day months, and leap years. It comes with the E. Howard name and a certificate of authenticity.

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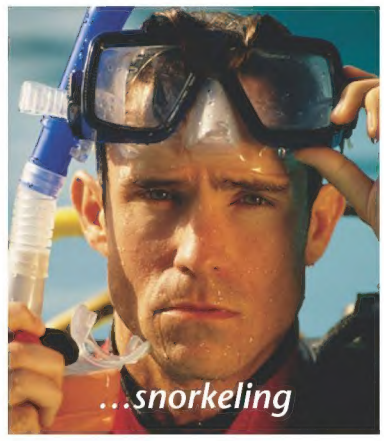

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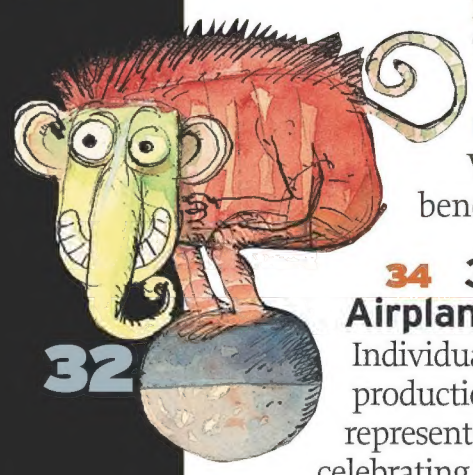
April/May 2007 | Vol. 22, No. 1

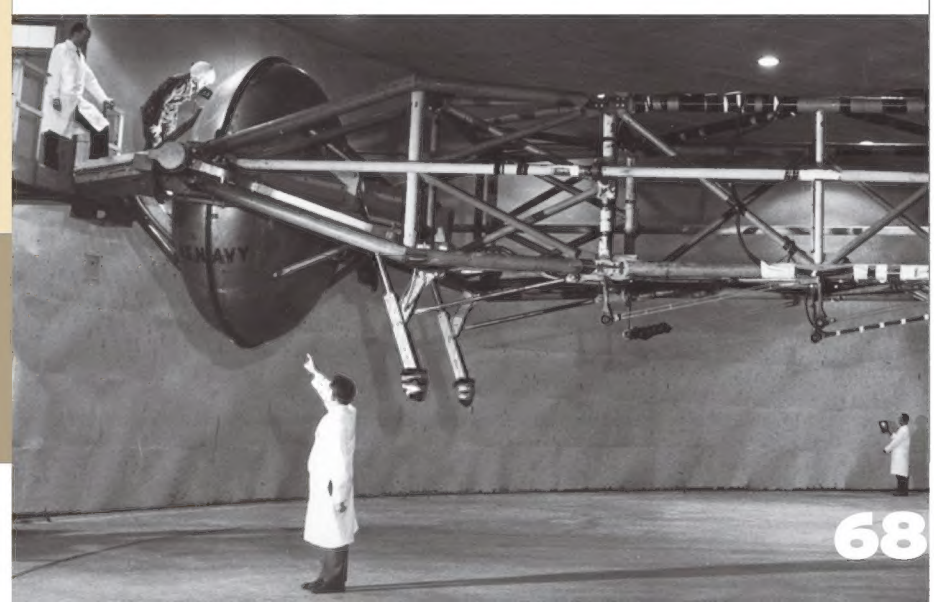
AIR&SPACE
Smithsonian

ON THE COVER A nine-ship formation in an arrowhead loop shows why Canadian Air Force Snowbird performances are over the top. Photographer Ken Lin managed to get all nine CT-114 Tutor jet trainers in the frame as the team mesmerized a crowd in Comox, British Columbia, last April (p. 40).

REV IT UP! *Air & Space* 2007 Airshow Special

Features





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Perfection from the laboratory. We will not bore you with the details of the ingenious process, but will only say that it involves the use of rare minerals heated to an incredibly high temperature of over 5000˚F. This can only be accomplished inside some very modern and expensive laboratory equipment. After cutting and polishing, scientists finally created a faultless marvel that's optically brighter and clearer with more flashes of color. According to the book *Jewelry and Gems–the Buying Guide* the technique used in Diamond*Aura* offers, *"The best diamond simulation to date, and even some jewelers have mistaken these stones for mined diamonds."*

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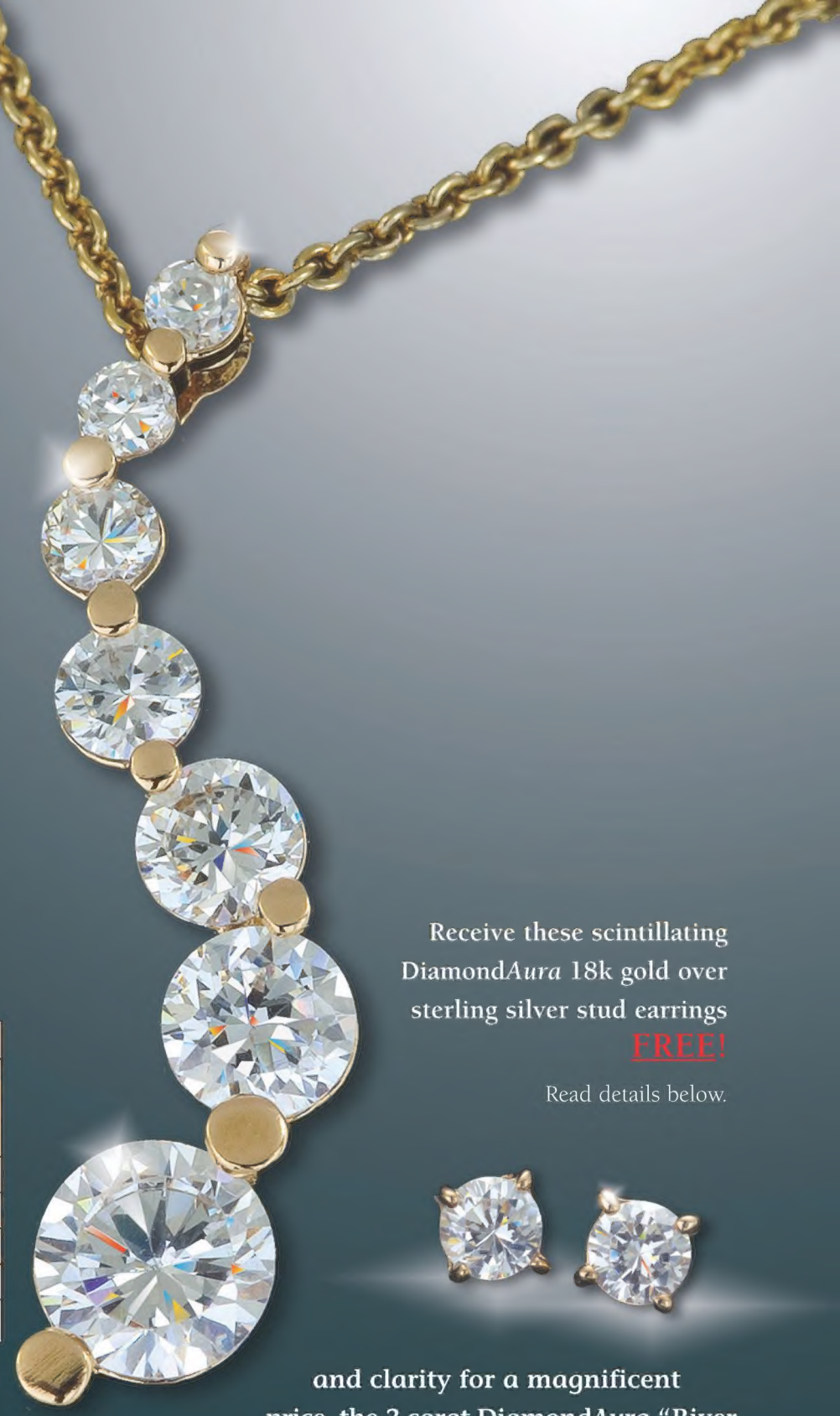

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R&R at the Museum

TO HONOR members of the U.S. military wounded in Iraq and Afghanistan, the National Air and Space Museum's Steven F. Udvar-Hazy Center created "NASM on the Road." The program provides tours of the Hazy Center for servicemen and -women recuperating at the National Naval Medical Center in Bethesda, Maryland, and the Walter Reed Army Medical Center and the Veterans Affairs hospital in Washington, D.C. Begun last fall, NASM on the Road has hosted 24 trips that have entertained 267 service members and their families.

The guests' day starts with a 90-minute docent tour and an IMAX movie, followed by lunch at McDonalds. (Because the program is fully funded through private individual donations, there is no cost to the guests, the federal government, or the Smithsonian Institution.) After lunch, NASM Deputy Director Joe Anderson welcomes the veterans to his office, thanks them for their service and sacrifice, and gives each a copy of *America's Hangar*, a book about the Museum.

The NASM on the Road program also reaches recuperating service members who are unable to leave the hospital. Volunteers visit their hospital rooms to give them a virtual tour of the Hazy Center with 3D images displayed on a laptop computer.

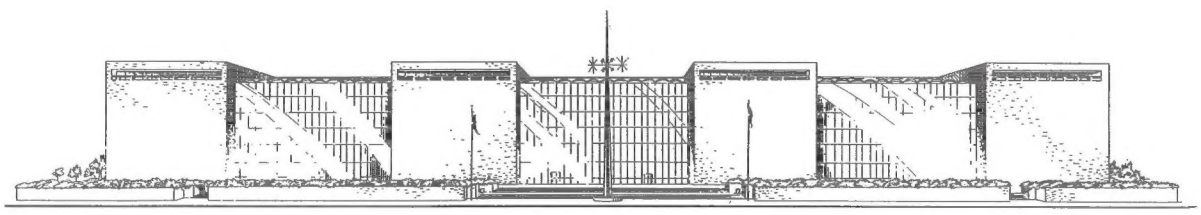
Last year, in conjunction with the June 2006 Become-a-Pilot Family Day, the program hosted a Caregiver Appreciation Day. The medical staff and technicians from Walter Reed and the Navy hospital were invited with their families to join in the Become-a-Pilot events. More than 235 caregivers enjoyed viewing the airplanes flown in for display as well as a catered picnic lunch. Museum hosts thanked them for their dedication in skillfully treating soldiers, marines, and air personnel injured in Afghanistan and Iraq.

In the future, the program will continue its focus on young people who have suffered physical and mental wounds and will expand its reach to veterans of World War II and the wars in Korea and Vietnam. The program will provide tours to those veterans residing in elder-care facilities.

The success of NASM on the Road has depended on the Museum's docents, who share their time, knowledge, and passion for aviation with the service members; the visitor services department, which provides wheelchair assistance and comfort; and the security staff, who are always nearby. Without volunteer Rick Jensen, whose year of service has saved the Museum any administrative cost, the program would not have been possible.

The entire NASM staff joins these volunteers in welcoming wounded U.S. service members home and thanking them for their sacrifice.

J.R. DAILEY IS THE DIRECTOR OF THE NATIONAL AIR AND SPACE MUSEUM.



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Letters

WRITE TO US

And Then There Were a Few More

Some of the aircraft types in "And Then There Was One" (Feb./Mar. 2007) have variants that still fly. There are a number of FM-2 Wildcats, manufactured by General Motors, still operating. While not exactly the same as an F4F, they are a very close variant and certainly represent the breed. Other F-86 models besides the A are still fairly common and active, particularly the F-86D and the Canadair Sabre.

Tom Blakeney
Fort Worth, Texas

Editors' reply: Readers also pointed out the following additional examples of last ones flying, and their owners/operators:

Curtiss SB2C Helldiver
Commemorative Air Force

Boeing P-26 "Peashooter"
Planes of Fame Museum, Chino, California

Grumman F9F Panther
Cavanaugh Flight Museum, Addison, Texas

North American FJ-4B Fury
MiG Fury Fighters

Mitsubishi A6M Zero (with original engine)
Planes of Fame Museum

Lockheed Hudson
Temora Aviation Museum, Temora, New South Wales, Australia

B-24J Liberator
The Collings Foundation

An Airplane We Shouldn't Have Bet You Never Heard Of

It is with deep regret that I inform you that you have lost your bet (see the cover, Feb./Mar. 2007). On June 14, 1948, at a Sunday morning fly-in breakfast at the Mackay, Idaho airport, there was a Zenith Z6A.

You may send the check to the address on this letter.

Ronald R. Jensen
Vancouver, Washington

A Hydrogen-Powered Helicopter?

In "No Runway Required" (Viewport, Apr./May 2006), Museum director Dailey mentioned that the Steven F. Udvar-Hazy Center's Vertical Flight exhibit includes the "XHOE-1 Hornet, powered by ramjets on the rotor tips." Many years ago while in the Bureau of Aeronautics, we had a program to develop the potential application of liquid hydrogen for power. This included an effort to use liquid hydrogen jets on helicopter rotor tips, with platinum as a catalyst. We actually tested such engines at a facility in the hills of west New Jersey, and were able to achieve satisfactory results.

This bit of history, known by only a few, would seem an appropriate addition to the Museum's Vertical Flight exhibit.

A.M. Carter Jr.
via e-mail

Forecast: Winds Continuing

It is true that the historic GALCIT 10-foot wind tunnel, under the leadership of the legendary Theodore von Kármán, served numerous industries and government agencies and helped make southern California the world capital of the aircraft industry. But "Model Behavior" (Feb./Mar. 2007) may give the impression that the Graduate Aeronautical Laboratories of the California Institute of Technology no longer operates wind tunnel facilities. In fact, GALCIT now possesses the new, high-tech, low-speed Lucas Adaptive Wall Wind Tunnel (*www.galcit.caltech.edu/awt*), and still plays a valuable role in the aerodynamic research and testing community.

Ahmad Farid Khorrami
Director of Operations,
Lucas Adaptive Wall Wind Tunnel
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Letters

COURTESY MIKE CAVANAUGH

A Sino Swearingen SJ30-2 model was tunnel-tested at the University of Washington, but only at low speed.

Your article states that Sino Swearingen "bypassed wind tunnel testing of the wing" of the SJ30-2. I was a member of the Sino Swearingen Aerodynamics/Performance Group from 1996 to after the loss of serial no. 002 in 2003. During that period, we conducted seven low-speed wind tunnel tests. I have included a photo (above) showing the model in the wind tunnel at the University of Washington. We also ran numerous computational fluid dynamics codes to investigate the high-Mach regime. The airfoil and wing were designed to operate in the transonic regime, so we were well aware of the presence of the wing shock. What we did not anticipate was the loss of lateral stability at high Mach. A transonic wind tunnel test would have likely identified the problem. The company's approach was to forgo such expensive testing and explore the high-Mach regime with CFD and careful incremental flight testing.

My experience has been that CFD codes are good for studying problems you have identified, but wind tunnel testing is better for identifying problems you did not know existed.

Mike Cavanaugh
Christiansburg, Virginia

Overlooked Aces of Vietnam

The announcement of the Commemorative Air Force's "Remembrance of War: Air Force Ace Over Vietnam" seminar (Calendar, Feb./Mar. 2007) refers to Brigadier General Steve Ritchie as "the only U.S. Air Force ace from the Vietnam conflict." There were three U.S. Air Force aces in the Vietnam War. In addition to Ritchie, Colonel Charles DeBellevue and Lieutenant Colonel Jeffrey Feinstein, both weapons system officers (rated navigators) flying in the rear cockpits of F-4s, achieved ace status.

Lt. Col. James T. Davenport
U.S. Air Force (ret.)
Las Vegas, Nevada

Corrections

Feb./Mar. 2007 "And Then There Was One": The U.S. aircraft registration number for the Grumman F4F Wildcat is NX12260.

"That Old-Time Profession": The pilot identified as Butch Dehart in the photograph on page 23 is actually Mark Edwards.

Dec. 2006/Jan. 2007 "The Thin Aluminum Line": The F-102A carried six, not four, AIM-4 missiles—three guided by radar and three by infrared.

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Concerto for Merlin and Double Wasp

PHOTOGRAPH BY DON "BUCKY" DAWSON, ILLUSTRATION BY DAVID PETERS

John Altmann thinks engines make beautiful music. He's sold thousands of CDs.

>>> **IT'S A CLEAR** morning in mid-September. Fifteen miles outside Reno, Nevada, John Altmann is in a van heading for the outskirts of Stead Airfield, a former Air Force base, now used by general aviation traffic and, once a year, by the association that stages the National Air Races.

Altmann has been making audio recordings of vintage aircraft engines for 25 years. What started as a hobby is now a business, AirCraft Records, which produces CDs featuring the sound of radial engines. Altmann's work has been used in the Howard Hughes biopic *The Aviator*, Discovery Channel's "Wings" series, and video games, and he has sold thousands of records and CDs.

Altmann sets up his digital recording equipment, a suite of electronics he has refined over the years. The hard disk recorder is the size of a cigar box. His custom microphone array looks like a piece of Darth Vader's helmet.

"I grew up in the flight path of Santa Rosa Naval Auxiliary Air Station," Altmann says. "My mom would take me out in the stroller near the runway and what I now know were P-38s would roar over.

"I became a recording engineer, and owned a music recording studio in San Francisco. In 1982, for my 40th birthday, I took a ride in a P-51. The pilot was Korean ace Bob Love—he had a beautifully restored two-seat Mustang in Livermore, California. The amazing sound of his Merlin 12-cylinder engine stayed with me. I thought, *Why not make a record of that sound?*"

Altmann says he used a complicated binaural dummy-head microphone and a reel-to-reel tape recorder jammed under the seat, which resulted in "a total disaster. I basically put a lot of rattling and wind noise on tape." He and Love made another flight with a smaller single-point stereo microphone and it worked beautifully. The first album, *CheckFlight P-51*, was released in 1983 and included a foldout poster of the Mustang's instrument panel. Today, vinyl copies are fetching $250 on eBay.

Love suggested that Altmann go to the Reno Air Races. "Toting around my microphones and tape recorder, I was pretty much of a freak, but I was adopted by the regulars because Bob Love introduced me to them," Altmann says. "Bob asked Ron Burda, an award-winning photographer for the *San Jose Mercury News*, 'to take this kid out to Pylon 6.' I had no inkling what was going to happen.

"All of a sudden, a pack of three P-51s came tearing through the skies flat-out, seemingly just above our heads, doing 400-plus miles per hour. My whole body was vibrating."

Since then, Altmann has captured the sounds of 20 years of air races, and has created audio documentaries on the P-38 Lightning, Messerschmitt Bf 109, Mitsubishi Zero, and Chance-Vought Corsair, and a CD set on World War I aircraft. A new project, on the U.S. Navy's Grumman "Cats" of World War II, is in the works.

KEITH HATSCHEK

Visit to a Small Planet

The Dawn spacecraft will orbit asteroids Vesta (at left) and Ceres (right).

WILLIAM K. HARTMANN/COURTESY UCLA

NASA'S DAWN MISSION recently gained unexpected fame when the International Astronomical Union's much-publicized planet vote promoted Ceres, one of the mission's intended targets, from just another asteroid to the new category of dwarf planet. (The vote also demoted Pluto from full planet to dwarf.)

"Ceres and Vesta [Dawn's first target] have been called asteroids; I see them as unexplored worlds," says mission project systems engineer Marc Rayman. Though they reside in the asteroid belt, between Mars and Jupiter, the appearance of the larger Ceres is unlike the typical jagged asteroid. It is nearly spherical, shaped by its own gravity (part of the IAU's new definition of a planet). Ceres, possessing about a quarter of the mass of all the objects in the asteroid belt, has a surface that promises polar caps and other planet-like features.

Dawn, scheduled to launch this summer, will reach Vesta in 2011. Its ion engine will provide a third of an ounce of thrust, boosting Vesta's speed by six miles per second until the craft reaches 50,000 mph. "I call it 'acceleration with patience,' " says Rayman.

"[Dawn] will image the surfaces of both bodies, take spectra to identify minerals, and measure variations in [each body's] gravity to probe their interiors—on Vesta for differentiated [planet-like] layers, and on Ceres for the possibility of internal water," Rayman says. Orbits will range from 125 to 3,650 miles above the surfaces. Aptly named, the Dawn mission is a trip back to the birth of the solar system—specifically, to when forces coalesced matter into the eight major planets. The smaller Ceres and Vesta apparently came close to joining the club before opposing forces intervened. "It's a rare chance to visit a planet under construction," says Rayman. "Part-way there, it just never completed the job."

NICK D'ALTO

Shoeless Joe Passenger

EACH YEAR 70 MILLION harried people pass through security checkpoints at Los Angeles International Airport – and often leave something behind. Last November travelers forgot nearly 500 items at Terminal 1 alone. Multiply that by the airport's nine terminals and you have a huge stockpile of watches, keys, toys, loose change – even dentures and baby seats. "You name it, we find it," says Nico Melendez, public affairs manager for the Transportation Security Administration's Pacific region, which supervises the airport security checkpoints.

Orphaned items are delivered daily to the TSA lost and found office near the airport. In a dim storeroom that resembles an unfinished basement, 15 TSA officers inspect, log, and store each item until the owner is found – or 30 days go by, whichever comes first. "After a month," says Melendez, "if we can't locate the owner, items valued at less than $500 are destroyed or donated to a non-profit agency," while high-value items are sent to the General Services Administration, a government agency that manages federal property.

Shelves 15 feet deep hold rows of 12-gallon plastic bins, each stuffed with clothing and other items. A walker leans against one shelving unit, near several umbrellas. Alfred Howard, the logistics manager for the lost and found office, opens a six-foot-tall safe. Inside are laptop computers, flash drives, luxury watches, and cell phones. "We collect over 400 cell phones each week," he says. If the owners aren't found within the 30-day limit, the cell carriers instruct TSA to destroy the phones. Driver's licenses are also destroyed if not claimed. Passports, however, go to the State Department in Washington, D.C., for disposition.

Thousands of dollars in bills and coins flow through lost and found every week. "Recently we found $5,000 in a bowl at one of our security checkpoints," Howard says. No one called to claim the cash, so it was sent to the U.S. Treasury, where it was placed in the general fund – the account where your income tax payments reside. "Someone paid his taxes twice," says Howard.

Each week, up to 500 travelers at LAX forget their belts. Though buckles aren't likely to trigger the metal detectors, many people take their belts off anyway – and abandon them as they rush to catch a flight. Some people even forget their shoes. "You'd think that if someone left their shoes behind, they'd come back to get them," Melendez says.

ALLAN T. DUFFIN

AVIATION-IMAGES.COM (2)

HOT HARDWARE

China's J-10 Goes Public

THOUGH THE MACH 2 Chengdu J-10 multi-role fighter has been in service with the People's Liberation Army Air Force since 2003, its existence remained top-secret until late in December 2006, when the Xinhua News Agency announced its active-duty status. "Project 8610" began in 1986 with the goal of producing an air superiority fighter equal to Russia's MiG-29 and Su-27. Composite materials make up much of the fuselage and wing, reducing weight and improving thrust-to-weight ratio. A fly-by-wire system, said to equal that of the F-16, provides performance that may top that of the Su-27, which uses a conventional control system. A two-seat trainer/electronic warfare version, the J-10B, entered service last year. The J-10 has been offered for export only to Pakistan, which plans to acquire 36 by 2010.

People's Liberation Army Air Force pilots parade past China's latest in pointy jets (right). The wings have 11 attach points for 10,000 pounds of weapons, fuel tanks, and electronic countermeasure equipment (left).

Delta Shocks Deity

LAST SUMMER, the Michael C. Carlos Museum of Emory University in Georgia spent roughly $1 million on two separate purchases—a headless marble statue of the Roman deity Venus and the head that had been on it when it was carved 1,900 years ago.

But before putting the goddess of love and beauty back together, conservator Renée Stein wanted details about the repairs, not visible to the naked eye, that had been made during the intervening centuries. So she went to the experts. Not the experts in ancient statuary—the experts in evaluating the components used in airliners.

Last November, Stein took her statue to Delta Air Lines' Technical Operation center at Hartsfield-Jackson Atlanta International Airport for X-ray testing. Her goal was to determine the condition of the many metal pins and rods that had been inserted into the marble by previous owners, and Delta's inspectors had plenty of relevant experience. "These guys are the experts in finding evidence of stress, cracks, corrosion, pitting, wear—the same issues we were interested in," she says.

Typically, Delta's X-ray crew evaluates components used in the engines of Boeing 767s and 757s and McDonnell Douglas MD-88s and -90s. The team has also worked on an old DC-3 and, in years past, examined two bronze artifacts for the museum. But marble was a new challenge, and Delta radiation safety officer Richard Watkins wasn't sure the X-rays could penetrate the 6.5-inch-thick head to get a usable view of the metal within.

Inside a large room lined with lead, the Delta guys cranked up the X-ray machine to 300,000 electron volts and shot Venus for a full minute. A diagnostic chest X-ray typically entails a one-second burst of 150,000 volts. But the X-rays didn't damage the statue, much to Watkins' relief.

"I was more nervous than

UPDATE

Ahead by a Nose Section

BOEING HAS PULLED ahead of Airbus in aircraft orders for the first time in five years (see "The Contender," Oct./Nov. 2003). At the end of 2006, Boeing had 875 total orders for 737s, 747s, 767s, 777s, and the upcoming 787 Dreamliner. Airbus logged 824 orders for A320 and A330 family airliners and its megaliner A380.

usual," he says. "If something goes wrong with an engine, GE and Pratt & Whitney have more parts. If something went wrong with the statue, we couldn't just go get another one."

After examining the film, Stein was gratified to learn that all of the previous repairs—dating back hundreds of years—appeared to be in good shape. Armed with this knowledge, as well as details about the exact position of the pins and posts, she anticipates no fundamental problems in reassembling the statue.

Watkins says the publicity surrounding the Venus project has led to another non-aviation assignment: X-raying a crate of Civil War-era rifles recently salvaged from a shipwreck. Stein, too, is eager to return to the Hartsfield facility with other projects: "Unless I get X-ray vision, which is on back-order, I'm going to continue going to Delta."

PRESTON LERNER

UPDATE

It Came From Outer Space

NASA ANNOUNCED it will spend up to $14 million on a dozen research projects in radiation biology ("The Invisible Killers," Dec. 2005/Jan. 2006). The 12 proposals, culled from a total of 82, are expected to aid in the development of effective shielding or biological countermeasures for radiation exposure experienced by the crews of future moon and Mars missions.

Michimasa Fujino

PRESIDENT AND CEO, HONDA AIRCRAFT COMPANY

AUTOMOTIVE GIANT HONDA MOTOR COMPANY caused a sensation in the aviation industry last year when it threw its hat – and considerable reputation and resources – into the bizjet ring with the eight-seat HondaJet, for which the new Honda Aircraft Company now has over 100 orders. At 483 mph, the HondaJet is the fastest aircraft in the lightjet class (under 10,000 pounds).

TIM LOEHRKE/USA TODAY

Fujino says the shapes of engine nacelle and pylon were critical in the HondaJet design.

How did an automobile company like Honda begin a project to design an airplane?

In 1986 Honda started the new fundamental technology center. There were several projects: airplane, jet engine, and humanoid robot. I was called by my boss to transfer from the automotive to the airplane division. The first project was to build the experimental aircraft called MH01 – "MH" for Mississippi Honda. Honda partnered with Mississippi State University to modify a Bonanza A36 with composite material. Honda management wanted to work with a university rather than a company because a university could keep a secret better.

I was the youngest member of the team and was treated like a technician. For the entire first year, I was just sanding a mold. Until I understood the importance of building the airplane by my own hand, that experience was very tough for me. But now when I look at a part, I can read it: I know the proper weight and thickness. Many designers in the United States do not have experience in building parts by themselves.

What was your inspiration for mounting the engines on top of the wings?

We designed the second project, the MH02, the first all-composite business jet for an advanced turboprop engine with very small diameter. The design was based on the pusher configuration, and the engine is mounted on the wing in a pusher. But during the development of the Advanced Turboprop design, the [ATP engine program] was terminated. Finally we decided to use an existing engine from Pratt & Whitney, and I was looking for a position where we can install the engine on the airframe. We had to use a large engine, which was a little too big for the airplane. There were many geometrical contraints. There was only one place where we could install the engine: over the wing.

Frankly speaking, the original MH02 is still facing some drag penalties at high speed because of the over-the-wing configuration. There is also some lift disadvantage as well. But the MH02 is a very low-speed airplane – .5 Mach number.

What has been the reaction to the wing-mounted engines?

The first time I proposed the configuration, everybody said, not a good idea from a technical standpoint. When I proved the technical advantage, they continued to say it's an ugly airplane. But when we pulled the airplane outside, people were very impressed. When they put the word "beautiful" in front of HondaJet, it is the best compliment for me now.

(Visit *www.airspacemag.com* for the complete interview.)

Model Employee

WHEN DAVE GIANAKOS isn't flying long-haul flights to Asia as captain of a Northwest Airlines Boeing 747-400, he's training pilots to do the same thing. In the little spare time he has left, he pursues his passion for building meticulous models of space- and aircraft, missiles, and rockets.

In 1992, Gianakos began a two-year project to build a Saturn V model to celebrate the 25th anniversary of the Apollo 11 moon landing. It was a sophisticated replica of the guided three-stage rocket, right down to a working escape tower equipped with gimballed motors and gyroscopes. Only the lack of working motors for the first stage prevented the mini-Saturn V from being launchable.

A year later, Gianakos generously donated his model to the National Air and Space Museum, where it resides in the Apollo to the Moon gallery. Not long after, the Museum commissioned Gianakos to build two additional display models: a 1/48th-scale model of the 1960s Soviet N1 moon rocket, built for the Space Race exhibit hall in 1996; and a 1/24th-scale Navaho missile, which has been on display at the Steven F. Udvar-Hazy Center in Virginia since its 2003 opening.

Gianakos started building models when he was a child to honor his father, a U.S. Air Force pilot who was killed in a B-47 crash when Gianakos was only 18 months old. His stepfather served as a U.S. Navy pilot in the Pacific during World War II. "I started reading [aviation magazines] at 10 or 11," says Gianakos, adding that when children are "fired up" by a topic, "their passion and interest can take them anywhere they want." In this case, Gianakos' enthusiasm for flying has taken him around the world with Northwest Airlines—and provided him a degree of aviation immortality.

Last July, Dave Gianakos replaced the 10-year-old lights on his Saturn V model's launch tower at the Museum.

"It's obvious that he's a superb model maker," says Roger Launius, former chair of the Museum's division of space history. "Because of the size of the real objects, it's impossible to display them at the Museum [on the Mall]. These smaller-scale renderings enable us to enjoy them in three dimensions."

Gianakos built other spacecraft and rocket models when he was in high school. Using a combination of NASA blueprints and his own ingenuity, he has built replicas of the Apollo 15 mothership, lunar module, and rover (all now exhibited at the San Diego Air and Space Museum); a 1/6th-scale lunar module, at the Seattle Museum of Flight; and a model of Alan Shepard's *Freedom Seven* Mercury Redstone rocket, at the Kansas Cosmosphere and Space Center in Hutchinson.

ERIC LONG (2)

"For the Saturn V model's Launch Umbilical Tower, I was able to procure actual welding drawings from NASA," says Gianakos. "Without those, I couldn't have built the tower to the same level of detail."

The three Gianakos models on display at the National Air and Space Museum represent achievements in the arms and space races between cold war superpowers. "Growing up in those times was awe-inspiring...for young people like me," says Gianakos, who was only six years old when Shepard made his historic flight. "We witnessed the space race unfold."

The Soviet N1 heavy rocket booster was supposed to be the means by which the Soviets were going to put a man on the moon. It was an enormous rocket, according to Gianakos, "every bit the equal of the Saturn V and even more powerful." Between 1969 and 1972, the Soviets attempted four launches of the N1, each of which failed, and they cancelled the program in 1974.

The Navaho was a U.S. Air Force intercontinental surface-to-surface missile designed to carry a nuclear warhead. Although the Navaho flew nine flight tests between 1956 and 1958, the project was cancelled due to cost overruns. "[The Navaho] was very important in the advancement of space technology and long-range navigation," says Gianakos.

Aside from the models, Gianakos' presence is felt in other, unexpected ways in the Museum. A new exhibit in the Air Transport Gallery will feature the nose section of a Boeing 747—the very one that Gianakos has flown a number of times in his career (see "Nose Job," below). It will be the first full-scale "model" of his in the Museum.

SARA DUNCAN WIDNESS

[Visitor Information]

Curator's Choice National Air and Space Museum curators occasionally give 15-minute talks about an artifact or subject of interest. Meet at the Milestones of Flight gallery at noon. Apr. 4, The Short-Lived Pershing II Missile; Apr. 18, Going for Altitude: High-Altitude Ballooning from H.C. Gray to Explorer II; Apr. 25, The HiRISE Camera Reveals a New Mars.

What's Up Receive regular updates on Museum events, read about artifacts, get detailed (and behind-the-scenes) exhibition information, and receive calendar listings by subscribing to the National Air and Space Museum's free monthly e-newsletter, *What's Up*. Sign up at *www.nasm.si.edu*.

Docent Tours Learn about the Museums' collections and trace the history of air and space travel on free, docent-led tours. At the Museum on the Mall, tours meet at the Welcome Center. At the Udvar-Hazy Center, tours meet at the Docent Tours desk in the Boeing Aviation Hangar. Tours run daily at 10:30 a.m. and 1 p.m.

New (and Discontinued) Bus Service The Virginia Regional Transportation Association is now offering convenient shuttle bus service between Washington Dulles International Airport and the Steven F. Udvar-Hazy Center. For detailed routes and schedules, visit *www.vatransit.org*, and click on "Bus Routes," then "Air and Space Museum shuttle." Shuttle service running between the National Mall building and the Udvar-Hazy Center has been discontinued.

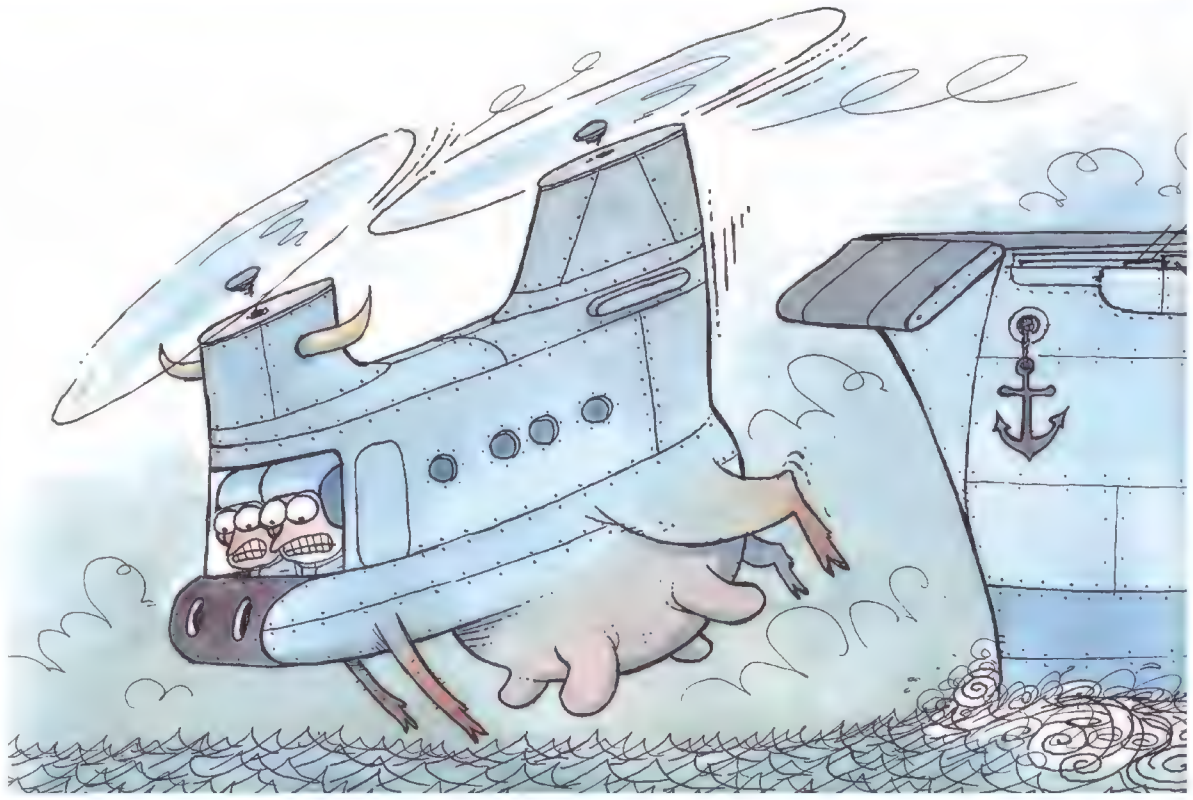
The Boeing 747 nose is the largest artifact ever to be hung in the National Air and Space Museum.

ARTIFACTS

Nose Job

A 747 NOSE SECTION IS THE LATEST addition to an exhibit called *America by Air*, scheduled to open in 2008 in the Museum's Air Transport gallery. Model maker Dave Gianakos flew the aircraft that donated its nose; the last time he piloted the 747, he flew 450 troops from Alexandria, Louisiana, to Eielson Air Force Base in Alaska, just a few months prior to the 747's retirement from Northwest Airlines service. For more information on the jet's big move, visit *www.airspacemag.com*.

Milk Run



FOR ANY NAVY PILOT flying aircraft carrier operations, the voice of the air boss, the officer in charge of all air operations on deck, is the sound of absolute authority. For this Navy helicopter pilot, the air boss represented trouble. He was a tyrant with a hair trigger.

In 1988 I was flying the Boeing CH-46 Sea Knight, a tandem-rotor helicopter deployed on the USS *Niagara Falls*, a support ship in the USS *Dwight D. Eisenhower* Carrier Battle Group. My crew and I delivered "beans and bullets" to the fleet. We hit the *Ike* every other day, restocking whatever was needed to keep a city at sea afloat. Ammunition, food, machinery, mail—referred to as "pony"—the ships in the battle group relied on us for everything except fuel. It was exciting, challenging flying, and I loved it. But always, just below the surface, was the fear of raising the ire of the air boss.

One morning, flying as Knightrider zero six, we launched before dawn on a replenishing mission. We moved tons of cargo attached as sling loads beneath the helicopter.

By noon we had only a load of internal cargo left to deliver. I radioed the carrier. "Boss, Knightrider zero six, 10 miles out for landing."

"Recoveries in progress. Take Starboard Delta," he replied, directing us into an established holding pattern.

We watched as jets made approaches and "trapped" (caught one of the arresting cables) or "boltered" (missed the wires and went around for another try). *We should be next*, I thought, once all the jets were aboard. But the voice of authority had other plans. "I've got another cycle 15 minutes out, Knightrider. I'll recover them first, then bring you aboard."

"Haven't got fuel for that, Boss," I said.

"Then go get some," he snapped.

He knew we could get in and out in five minutes, but he was the air boss, so I bit my tongue and turned for the *Falls*. Then I remembered those orange bags marked U.S. Mail. In a mariner's heart, mail call ranks just below liberty call. Not even an air boss can resist mail call. I keyed the microphone. "We have pony aboard, Boss."

Everyone in the control tower would be staring at him. If he didn't land us, all 6,000 sailors aboard would soon know he had denied them a mail call.

"Knightrider, you're clear to land, spot three," he relented, specifying the forward spot on the angled flight deck.

I flew a shallow approach, careful not to let my rotor wash disrupt his flight deck. As soon as I touched down, my aircrew lowered the ramp and began pushing pallets down the rollers to the forklifts. Minutes after receiving the air boss' grudging clearance, we were empty and ready to go.

"Knightrider zero six, ready to lift, spot three," I transmitted.

"Stand by, Knightrider," he said. "Supply wants you to move a load of milk back to home plate for dispersal. How many gallons can we load, max?"

With our fuel load, we could lift about 7,000 pounds, but I hadn't a clue as to how many gallons of milk that would be. I looked over at Dave, my copilot. "Any idea what milk weighs?"

Dave shrugged and turned his palms upward in what is known in Navy parlance as an ensign's salute.

"I need a number, Knightrider," the air boss growled.

Forklifts began driving off the elevators with pallets of milk. I pulled the calculator out of my helmet bag and typed 7000. Now I just needed to know what to divide it by.

"Knightrider! I need a number—*now*."

"Milk must weigh about the same as fuel, right Dave?"

Dave gave me another ensign's salute.

I knew that jet fuel weighed about 6.5 pounds per gallon. Even though the voice in my head told me to slow down and think this through, I decided that a liquid was a liquid. I plugged 6.5 into my calculator. Just as the Boss started to growl again, I transmitted, "One zero five zero gallons, Boss," with far more confidence than I actually had. It was meager comfort that I had figured in a 27-gallon cushion, just in case milk was a little heavier than fuel. How much heavier could it be?

"Okay, Knightrider. Here it comes. Be ready to lift as soon as we stuff you."

In minutes the cabin was crammed with hundreds of plastic jugs that I prayed weighed no more than my hasty calculation.

"Knightrider, cleared for takeoff."

I pulled the aircraft into a hover and

DAVID CLARK

stabilized it for a ground-effect power check.

Ground effect—the cushion of air that provides extra lift for a helicopter operating within one rotor diameter of the surface—can be a blessing or a curse. With a long hovering run, a pilot can accelerate in the ground effect cushion until reaching flying speed, thereby lifting far more than would be possible from a standard climbing transition. The carrier, however, presented the opposite situation. From our position adjacent to the deck edge, I would take off into a ground-effect hover, then transition over the edge of the flight deck, 90 feet above the water, to an immediate loss of ground effect. The voice in my head warned me as I raised the collective to increase rotor pitch and add engine torque, but the big voice in my headset drowned it out: "I need my deck, Knightrider!"

Normally I would have taken my time to evaluate a takeoff this critical. But this was the air boss' deck, and he wanted it back. "Get that damn helo off my deck, now!"

Without the stabilized torque reading that would tell whether the aircraft would fly at this weight, and against my better judgment, I eased the cyclic stick forward and the aircraft lumbered across the deck edge.

Immediately we were in trouble. The aircraft settled, and I instinctively countered by raising the collective. But instead of slowing its descent, the helicopter settled faster. The steady hum of the rotors changed to a distinct *whump whump whump*, and the familiar blur of the rotors slowed until I could see each individual blade. A quick glance at the instruments confirmed that both engines were operating normally. I was simply demanding more power than they could produce, and the strain was making the rotor speed decay.

I should have predicted what would happen next. With a jolt, both generators kicked off and we lost everything electrical. Powered by the rotor system, the generators had been designed to "shed," or drop offline, at 88 percent of optimum rotor speed to preserve torque for lift. The jolt was the loss of the flight control stability system. The helicopter was still controllable, but controlling it took far more work without the stability system. Things were starting to go very badly.

As the rotor speed continued to decay, I realized the only chance we had was to get back into ground effect. If I continued wallowing, the helicopter would "run out of turns"—lose lifting rotor speed—and crash, or settle into the ocean and sink. I had to try what the old salts called "scooping it out."

Faced with an undesirable sink rate, it is counterintuitive to decrease either power or pitch, but scooping it out required both. To dive back into ground effect, I lowered the nose, and the windscreen filled with the sight of blue water and white foam. To preserve rapidly deteriorating rotor speed, I lowered the collective. The bottom dropped out and the ocean rushed upward. I blurted "Brace for impact!" Dave immediately understood what I was attempting and began calling altitude and rotor speed.

"Fifteen feet, 84 percent."

I needed airspeed. I had to trade more altitude to get it, so I eased the cyclic forward a little more.

"Five feet, 84 percent."

I checked the descent and stabilized in the ground effect run.

"Three feet, 83 percent."

We were flying, and the rotor speed had stabilized, but I couldn't seem to coax any acceleration out of it. This low, even a rogue wave could bring us down. *Milk*, I thought. *Evil stuff.*

With only the speed I had bought with the dive and no sign of acceleration, I despaired. Then the old salts spoke to me again. *If you ever need a little something extra, try a 15-degree right yaw. The drag is negligible, but your aft rotors get undisturbed air.*

What did I have to lose? I tapped the right pedal and the helicopter yawed.

"Two feet, 84 percent."

This was the air boss' deck, and he wanted it back. "Get that damn helo off my deck, now!"

Running through ditching procedures in my mind, I suddenly noticed the waves gliding by faster than they had only seconds before. Slowly, almost imperceptibly, we were accelerating.

I glanced at the airspeed indicator and my heart leaped: It was passing 40 knots. Then I felt that beautiful shudder every helicopter pilot knows as translational lift, the point where the aircraft is flying like an airplane more than hovering like a helicopter.

"Five feet, 90 percent."

Then another jolt—the generators were back, bringing the stability system with them. I accelerated through normal climb speed. At 90 knots and with rotor speed back, I finally had the confidence to leave the ground cushion that had saved us. Climbing through 100 feet, and over a mile from the carrier, the voice of authority once more rang in my headphones. "Great to see you flying, Knightrider. We were all holding our breath up here."

So, the air boss had a heart after all.

Turning for home, I passed the controls to Dave, took a deep breath, and noticed that my hands were shaking. I'd made a rookie mistake, and very nearly paid for it with four lives and a helicopter.

I later learned that milk weighs 8.7 pounds per gallon, a far cry from the 6.5 I had estimated. I had taken off from the carrier more than 2,100 pounds overweight, not counting the weight of pallets and packaging.

That was 20 years ago. Now I'm the old salt. Thousands of flight hours later, I still remember what I learned that day. Never allow external pressures to force a decision on any matter of safety. And never ignore the voice in my head that says something isn't right. Frequently it is the only one making sense.

And when the guy at the supermarket asks me how I want to carry my milk, I always tell him to double-bag it.

CHRIS MCKENNA

Strategic Car Power

DURING THE COLD WAR, while the fighting in Korea raged, the runways of Strategic Air Command bases in the United States were overrun with thundering hordes of powerful, high-speed, technologically sophisticated...race cars.

Between 1952 and 1954, the Sports Car Club of America held dozens of races on SAC bases. The spectacle of Ferrari 340s and C-Type Jaguars dicing at 170 mph against a backdrop of Convair B-36s and Boeing B-47s drew huge crowds to remote airfields. "It really helped get sports car racing off the ground in this country," says racing icon (and World War II flight instructor) Carroll Shelby, who competed in several of the events.

The SAC races were proof that war and politics make strange bedfellows. The SCCA, founded in 1944 by Eastern blue bloods, catered to the upper crust. SAC, devoted to long-range bombers packing nuclear payloads, reflected the militant temperament of its stogie-smoking commander, General Curtis "Iron Ass" LeMay.

LeMay worried that lousy living conditions were discouraging airmen from reenlisting, so he and his right-hand man, Lieutenant Colonel Reade Tilley, hatched a plan. LeMay was a racing fan who owned an Allard, a high-strung British sports car, and Tilley sometimes raced in SCCA competition. The two of them decided to stage races on SAC bases to raise morale and money for the Airmen's Living Improvement Fund, which would pay for furniture, TVs, and other goodies for enlisted men.

The timing couldn't have been better. Virtually all U.S. racetracks of the day were ovals, which weren't appropriate for sports car competition. Most SCCA races were conducted on circuits fashioned out of public roads closed for the occasion. In September 1952, a boy was killed and 12 spectators injured at Watkins Glen, New York, when SCCA president Fred Wacker, driving an Allard, veered off course on a start-finish straight that was in the town and plowed into the crowd.

Race cars mixed it up with nuclear bombers at Strategic Air Command bases in the early 1950s.

A month later, desperate for safer venues, the SCCA ran a series of trial races on a circuit cobbled together from runways and taxiways at Turner Air Force Base in Albany, Georgia. The main event, the four-hour Strategic Air Power Race, was won by P-51 pilot John Fitch in a home-grown Cunningham C4R powered by a honking Chrysler hemi. An estimated 60,000 fans attended the event, which raised nearly $50,000.

Buoyed by this success, Wacker committed the SCCA to a full slate of races on SAC bases the following year. The SCCA's SAC era officially began in February 1953 at MacDill Air Force Base in Tampa, Florida. Fitch won again in his ground-pounding Cunningham, this time before a crowd estimated at 90,000.

While the wide, right-angle runway circuits were fast and safe, they weren't very challenging. "It was a stopgap solution," Fitch says. Adds racer Bill Pollack, who competed at March Air Force Base in California: "Road circuits were more fun because there were more twists and turns and more changes of elevation." Still, fans showed up in record numbers. And so did drivers, including every top U.S. road racer of the era—Fitch, Shelby, Phil Hill, Phil Walters, Masten Gregory, Jim Kimberly, Bill Spears, and others. Tilley even managed to sneak in some seat-time in LeMay's Allard.

In February 1954, the *Tampa Tribune* published a letter from two MacDill airmen complaining that they'd volunteered to work at the races "in the sense that the Chinese volunteered to aid the North Koreans." Kansas Republican Errett P. Scrivner, chairman of the House Appropriations Subcommittee on Defense, raised a stink, and SAC's racing program was shelved after the 1954 season—despite raising $1.5 million (in current dollars) for the Airmen's Fund. "All we wanted to do was help a bad situation," an unnamed SAC official griped at the time. "You'd think we were trying to rob a bank."

As the cold war ebbed, SAC became increasingly irrelevant, and was finally disbanded in 1992. The SCCA continues to sanction sports car races all over the country, sometimes even on active airfields—but no longer in the shadow of LeMay's nuclear bombers.

PRESTON LERNER

COURTESY FRANK SHEFFIELD

To some, sunglasses are a fashion accessory…

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Drivers Alert: ***Driving can expose you to more dangerous glare than any sunny summer day at the beach can…do you know how to protect yourself?***

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NASA's researchers looked to nature for a solution.

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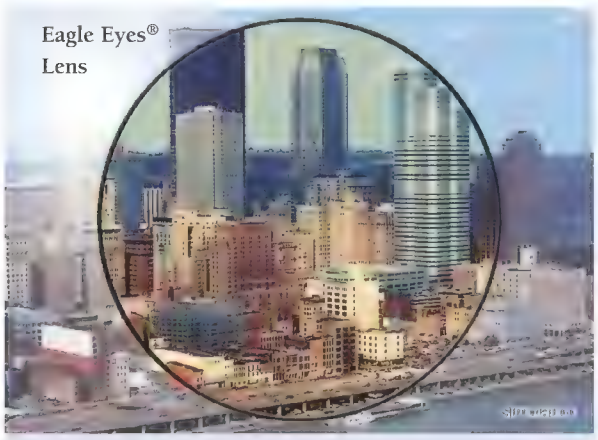

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> *—Dr. Lyda D. Tymiak*

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CAN WE STOP A NUKE?

WHAT THE LATEST ROUND OF MISSILE DEFENSE TESTS PROVES.

BY BEN IANNOTTA

ON SEPTEMBER 1, 2006, a handful of uniformed U.S. service members and Congressional staffers gathered in a windowless room in the headquarters of the Missile Defense Agency, tucked within a row of nondescript buildings on a low hill overlooking the Pentagon. The guests waited anxiously in the room, called the Management Information Center, watching several large computer displays on the wall in front of them.

They were about to find out whether the Missile Defense Agency could stop an intercontinental ballistic missile by shooting it down with an interceptor missile. This would be the first test of an interceptor launched as though the country were responding to an actual attack on its homeland. Previous interceptors were fired from Kwajalein Atoll in the Pacific Ocean; this one was to be launched from California.

The target rocket had been fired by U.S. forces on Kodiak Island, Alaska. On the screens in the Management Information Center, a red line, progressing southward from Alaska toward the west coast of the United States, represented its position. The target missile's path was similar to the trajectory that a Taep'o-dong 2 long-range missile launched from North Korea might follow. The difference, of course, was that if the September test failed, the Kodiak-launched target would splash down harmlessly off the Baja peninsula.

The anti-missile system that is, by the order of President George W. Bush, being fielded as it is developed, is a complex web of layered defenses, each aiming at a separate missile threat. Some are meant to thwart missiles as they rise from the pad (the pre-boost phase), while others are designed to destroy them as they descend toward the target (the terminal phase). The flight time between the two phases is called the "midcourse." Midcourse defenses are the only ones currently fielded against long-range threats, like ICBMs.

The focal point of the agency's September test of its Ground-based Midcourse Defense system was the interceptor missile, launched from Vandenberg Air Force Base in California. According to plan, it would rise out of Earth's atmosphere and release an infrared-seeking projectile called a "kill vehicle" that would collide with the target somewhere over the Pacific.

Watching the red line's progression across the screen in the information center, Air Force Lieutenant General Henry "Trey" Obering, director of the Missile Defense Agency, had something to prove besides the capability of hitting a bullet with a bullet.

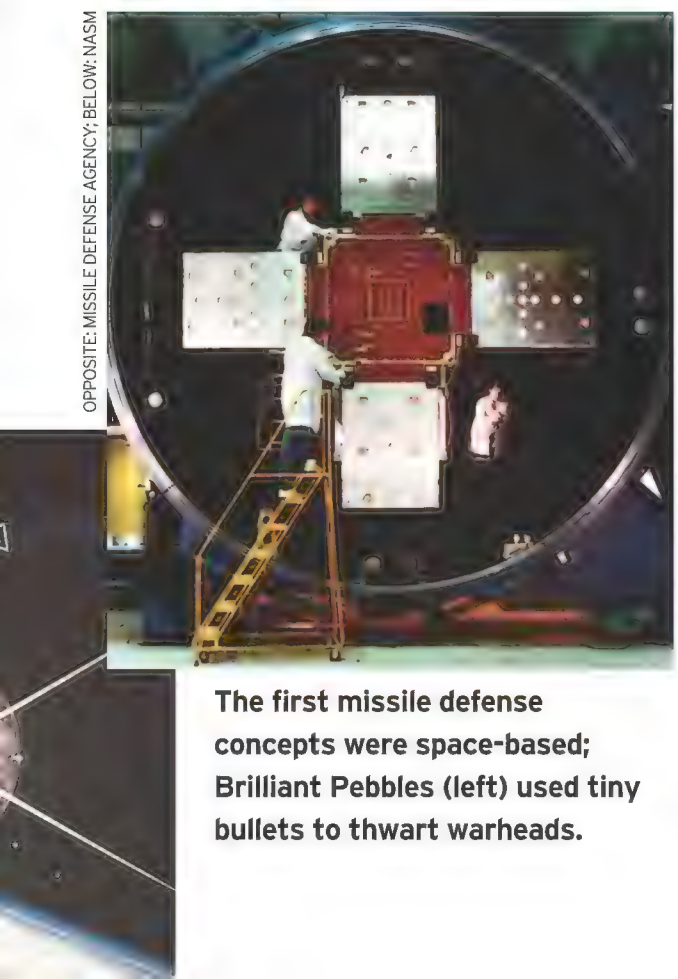
Obering, who had spent seven years helping NASA launch space shuttles, compares the feelings surrounding a missile test to the emotions evoked by a shuttle launch: "It was kind of scary, because with all the models and simulations, you just didn't know exactly what was going to happen until it did."

With this test, his agency was attempting to redeem itself for a series of failures that had called its competence into question. The lack of midcourse interceptions in the MDA program also suggested that that the technology was not mature enough to handle the task.

Since they were initiated in 1997, midcourse defense test flights have had mixed results. Between October 1999 and July 2001, three of five intercept tests had ended in success. But there had been a four-year lull in midcourse intercept launches, and only failure when they restarted.

The last time the missiles flew, in December 2002, the kill vehicle did not separate from the interceptor that carried it. Two years of work followed, during which Obering took over the Missile Defense Agency. Engineers

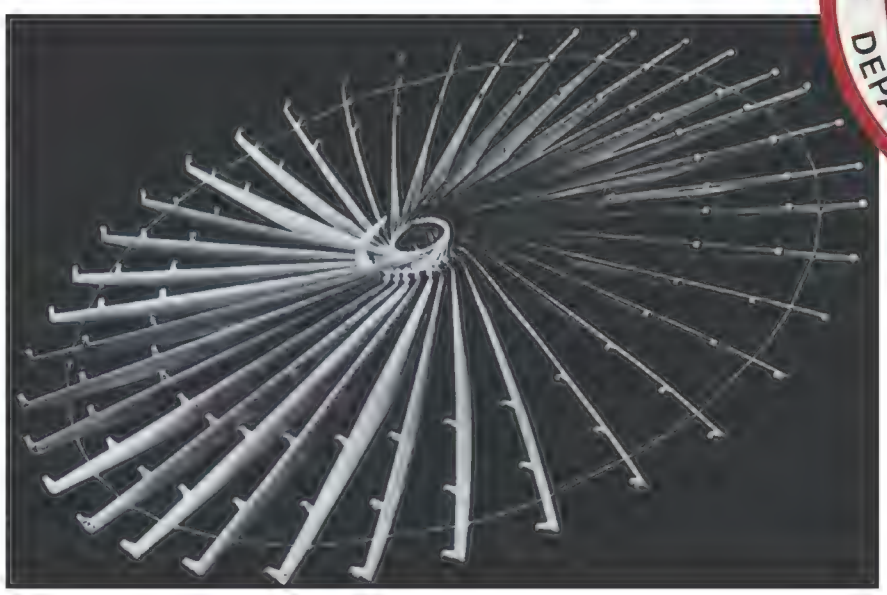
OPPOSITE: MISSILE DEFENSE AGENCY; BELOW: NASM



Strategic Defense Initiative staff build a satellite (left) to measure the distortion of lasers in space.

The first missile defense concepts were space-based; Brilliant Pebbles (left) used tiny bullets to thwart warheads.

OPPOSITE: MISSILE DEFENSE AGENCY; RIGHT: DEPARTMENT OF DEFENSE



Some kill vehicles from the 1980s featured 15-foot aluminum ribs that would open just before colliding with a missile.

from Raytheon Company cleaned up the design and began production of the kill vehicles at their Tucson, Arizona facility.

The first midcourse intercept of Obering's tenure was supposed to take place on December 15, 2004, but on that day the interceptor never appeared. A launch computer refused to let the interceptor leave its test silo on Kwajalein. The $10 million test target, already arcing through the fringes of space, fell into the sea.

Orbital Sciences Corporation, the interceptor's Dulles, Virginia manufacturer, had programmed the rocket with the tolerances of a satellite launcher. When a few status reports failed to reach the interceptor's flight control computer, it aborted the launch as though there were an expensive satellite aboard. The problem was fixed by writing a new line of computer code.

Obering's team tried again in February 2005. This time the interceptor refused to leave the silo when one of three support arms designed to keep the rocket upright during an earthquake failed to retract. Another $10 million target was wasted. Shoddy work at Kwajalein was blamed for allowing saltwater to seep into the base of the silo, making the air humid and causing glue in the support arms' hinges to swell.

After that, even the most vocal supporters of the missile defense plan advocated by President George W. Bush blasted Obering's agency. One Republican congressman from Alaska, Terry Everett, then chairman of the subcommittee that oversees missile defense, declared that he and his fellow members "were disgusted by the failings, because to be honest with you, it didn't appear to be brain science."

Inside the missile agency's headquarters in September 2006, the red line of the target grew on the display map for 16 minutes and 40 seconds before a blue line appeared on the southern California coast: A brigade with the Army's Space and Missile Defense Command had launched a single long-range interceptor from a silo at the Vandenberg base. So far, so good—at least the interceptor was airborne.

IF THE UNITED STATES comes under attack, plans call for interceptor missiles in Air Force bases at Vandenberg and Fort Greely in Alaska to roar out of holes in the ground to the fringes of space, where they would release the 155-pound kill vehicles.

Even as interceptors are being deployed—the U.S. has already fielded 14 interceptors in Alaska and two in California—the Missile Defense Agency must continue to develop the system through a series of $100 million tests. To accomplish this, the agency has a $10 billion annual budget that by 2016 is expected to climb to $15 billion, according to the Congressional Budget Office.

When one looks at what must go right in the first minutes of an actual attack, it's easy to see why Obering's job is unenviable, and his agency's budget so vast.

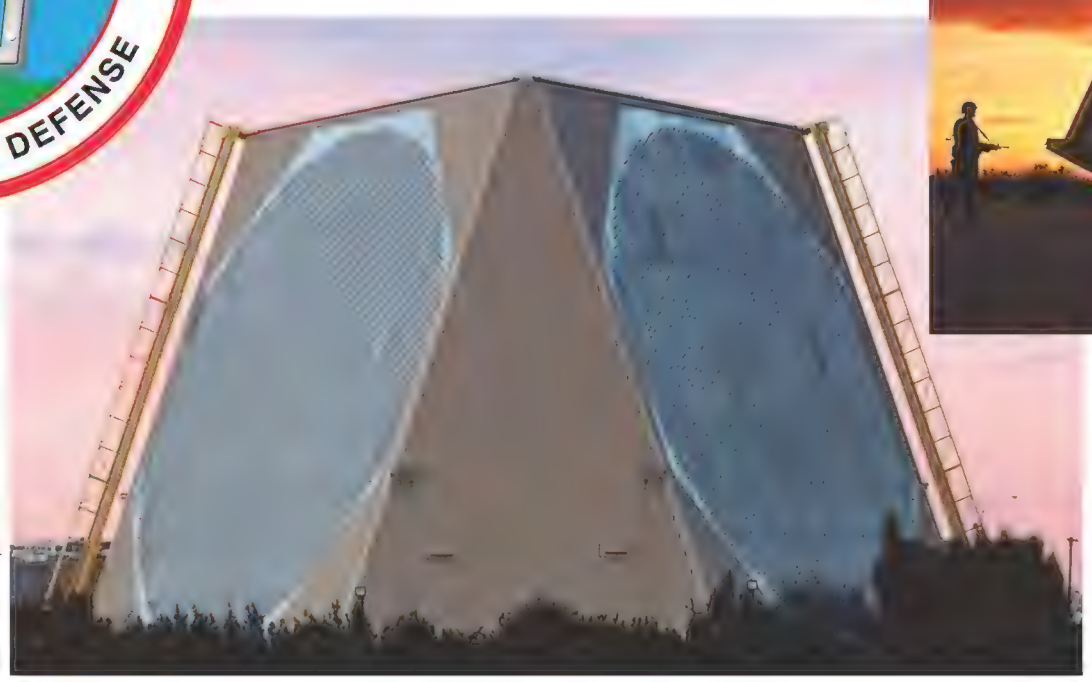
An attack would first be detected by U.S. Defense Support Program satellites, which sense the infrared radiation of enemy missiles rising from their launch pads. The first generation of this system was launched in the 1970s, but upgrades in new satellites have brought modern capabilities to the space imager system.

The satellites would tell ground radars where to look in the sky to find the enemy rockets after their engines burned out. The ground radars—someday to be augmented with sophisticated ground and space sensors—would transmit tracking coordinates to U.S. Strategic Command control rooms in Alaska and Colorado, where members of a specially formed Army brigade would pull the trigger on the interceptor missiles.

Computers would feed targeting data to the interceptor missiles via fiber optic cables and satellites. These initial "weapon task plans" must arrive before the missiles blast out of their holes so that their nozzles can be pointed at the incoming warheads.

All that must happen within 16 minutes. Any later and the defense would fall to radar-guided rockets, or "terminal defens-

U.S. ARMY



ABOVE: NASM; RIGHT: COURTESY RAYTHEON

The ballistic missile early-warning system has been in place since 1959. By 2001 the system was upgraded with 12-story phased-array radar sites like this one (right) in Alaska.

Layers of protection mean extra security. Terminal High Altitude Area Defense (above) and upgraded Patriot systems (right) handle theater missile threats.

es," fired as the warheads are falling through the atmosphere toward their intended victims. Most terminal systems, such as variants of the Patriot missile battery and the Terminal High Altitude Area Defense, are designed to target short- and medium-range theater missiles, not long-range ones.

Assuming the interceptor missiles make it into the air by their deadline, information from ground-based radars will provide the interceptors with updated information on the targets' location as they rise to meet them. As the distance closes, the interceptors will release their kill vehicles.

By this time, the enemy missiles will have dissolved into a hail of objects streaking toward the United States at perhaps 15,000 mph. Inside that cloud of warheads, inflated Mylar decoy balloons, shaped and painted to look like real warheads, could distract the kill vehicles, if not for the guidance given by their infrared eyes and small thrusters. If all goes well, each kill vehicle will collide with an incoming warhead at about 18,000 miles per hour.

Until new sensors are created, finding the real warheads among the decoys requires a shotgun approach: "If I can't discriminate what's a decoy and what's a warhead, I have to launch interceptors at both of those objects," Obering says.

But in September 2006, the goal was to direct a single kill vehicle to a single target warhead, using upgraded tracking radar at Beale Air Force Base in California. The Beale radar was built during the cold war to bounce radar waves off incoming Soviet missiles with just enough fidelity to tell the president: "We have a missile and it's going to impact in the New York or Chicago area," Obering says.

During the hiatus between launches, the missile agency put engineers and software experts to work installing new computer processors and software to enable the cold war radar to track objects with greater precision. Similar work is under way at the Fylingdale early-warning radar installation in England, enabling it to track missiles that might be launched westward from Iran. New sea-based platforms will supplement the early-warning radars. The more eyes available, the better, say planners.

The Beale radar upgrades were but one of many technical goals of September's test. An underlying goal was to restore confidence in the missile agency itself. Obering's reputation was riding on the 55-foot-long missile streaking across the Pacific, receiving guidance (he hoped) from the radar at Beale.

As the witnesses watched, the red and blue lines of the missile flight paths closed in on each other. Suddenly, 23 minutes and 20 seconds into the test, the altitude and velocity numbers froze.

Through an audio link Obering could hear the jubilant reaction inside the fire control room at Schriever Air Force Base near Colorado Springs. "Everybody started screaming," he says. "We knew we had achieved the intercept."

LOCKHEED MARTIN

The Other Missile Threat

WHEN IT COMES TO enemy missiles, an attack on the continental United States is not the U.S. military's only concern. Air Force Major General William Shelton, whose job as commander of the 14th Air Force is to protect U.S. spy satellites, points to a scenario that he considers unlikely but "absolutely catastrophic."

An enemy could launch a nuclear warhead not toward the United States but up and out of reach of the interceptors in California and Alaska silos. "If somebody decided to launch a nuke straight up and explode it, it literally wipes out the low-Earth-orbit satellites," Shelton says.

A nuke set off outside the atmosphere would cause limited and localized electromagnetic pulse (EMP) damage on the ground, but play havoc with satellites around the globe. Particles loosed in an explosion would produce an electromagnetic charge between them. The loose particles would conform to the planet's magnetic field, forming an electromagnetic band around the planet that would fry any electrical equipment in its path.

If North Korea pursued such a high-altitude EMP attack, it could blind nearly all satellites in low Earth orbit. "Now in most cases, you consider that to be self-deterring because you not only take out everybody else's satellites, you take out your own. But for countries that don't have anything necessarily at risk..." Shelton cuts himself off.

Boeing's Airborne Laser aircraft, a heavily modified 747 airliner, is the MDA's best hope for shooting down missiles as they are accelerating toward space, in what is known as the boost phase. It is being prepared for the first inflight tests of its high-powered laser; the first trial intercepts are planned for next year. It is not known if or when it will be deployed for service.

Asked about the threat to satellites from space nukes, Shelton shrugs. "The preferable thing is, in my mind, to address it in what's euphemistically called 'the pre-boost phase.' "

Translation: Destroy a suspicious rocket as soon as possible after it appears on the launch pad.

ALTHOUGH OBERING TOLD REPORTERS that the test showed the United States now had a "good" chance of shooting down a North Korean missile, Marine Corps General James E. "Hoss" Cartwright, as head of U.S. Strategic Command—the man responsible for defending the United States against a missile attack—sounds less convinced of the chances for a real-world success.

"We have another year minimum of the [research and development] for the rudimentary system," he says. "We want to be working with MDA to figure out what bugs are still there. What needs to be worked out? What tweaks?"

Cartwright would be on the front lines of any future missile attack. He is also the major customer of the tools MDA develops. The Army Space and Missile Defense Command, whose brigades fire the interceptors, is part of Strategic Command's purview. Speaking about the missile defense system he may have to use, he is open in airing doubts: "Are there components that fail in 50 days instead of 100 days? When they fail am I left completely disadvantaged?"

Perhaps cognizant of the differing assessments of Obering, Cartwright, and others, President Bush split the difference in public comments after the test: The United States now had "a reasonable chance" to intercept the Taep'o-dong 2, he said. "At least that's what the military commanders told me."

Some interested observers of the Ground-based Midcourse Defense test give the system an even smaller chance of success. Philip Coyle, 72, a former nuclear weapons designer at the Lawrence Livermore National Laboratory in California, is now an advisor to the Center for Defense Information, a left-leaning think tank in Washington, D.C.

In August 2000, as assistant secretary of defense for test and evaluation at the Pentagon, Coyle advised President Bill Clinton not to develop or field the ground-based interceptors that would eventually become the centerpiece of Bush's proposed missile defense plan. In Coyle's opinion, too many unanswered questions about the system's readiness remain.

He points to the lack of tests against countermeasures, delays in the advanced radar designed to differentiate decoys from warheads, and the small number of test successes as evidence that the system being developed could not handle a real-world threat.

"[The Missile Defense Agency] sort of dumbed-down the threat...because nobody believes they can handle 10, 20 or 100 missiles from North Korea," he says.

Sending solitary target missiles into the air as targets and successfully intercepting them gives the American public and policymakers a dangerously false confidence in the system, he adds.

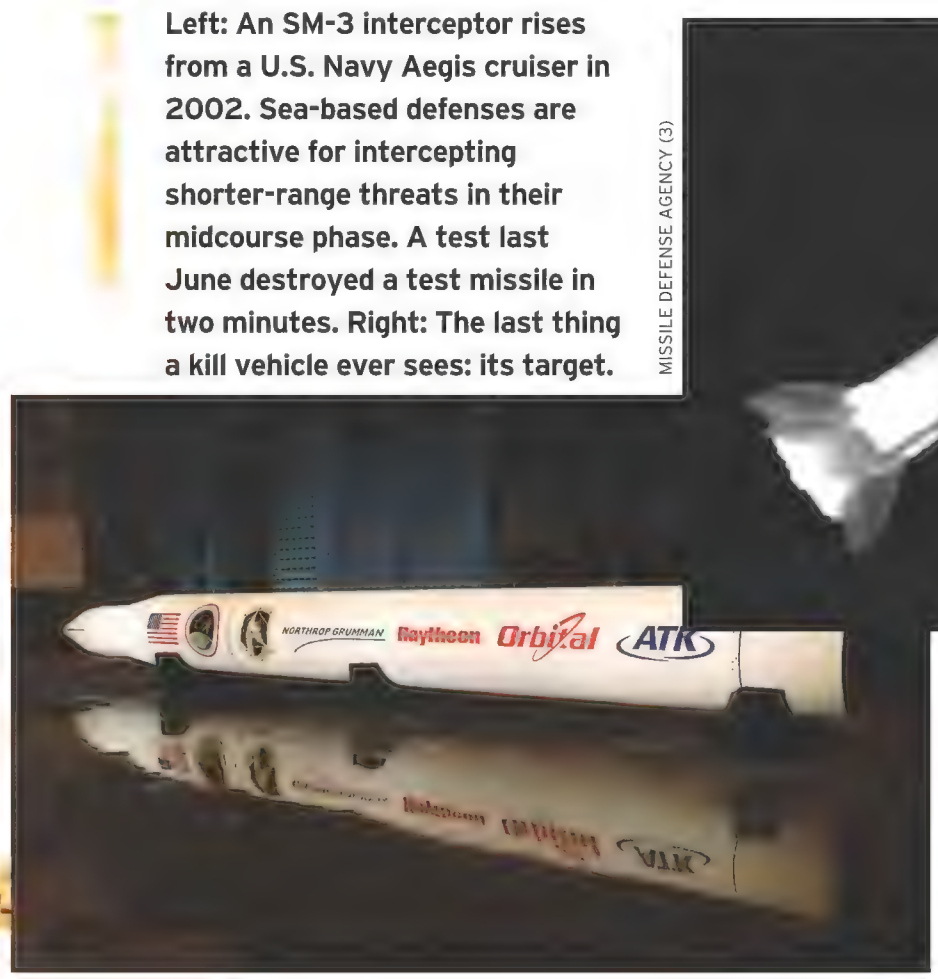
Indeed, with so many elements of the missile defense system still in development, the successful September test assumed only the simplest of threats—a single missile with no decoys or countermeasures. Earlier MDA tests used spoofing, including balloons in 2002 tests and specially designed parts that, after they break away from the missile, mimic warheads in shapes and temperatures. Coyle and other critics say the decoys are too easy to discern from the mock warheads, nullifying the positive results.

Coyle's real target is not just the system's technological flaws, but the entire strategic justification for missile defense. Success, he argues, could be more dangerous than failure.

Consider China, he says: "If they believe, like we hope North Korea would believe, that we have a missile defense that works, they're likely to do what Russia did many years ago, which is build hundreds or thousands of warheads and ICBMs so they can overwhelm the most futuristic missile defense system we can imagine."

Obering himself agrees that the system he's fielding will not have "operational capability" until it can handle multi-

U.S. NAVY



MISSILE DEFENSE AGENCY (3)

Left: An SM-3 interceptor rises from a U.S. Navy Aegis cruiser in 2002. Sea-based defenses are attractive for intercepting shorter-range threats in their midcourse phase. A test last June destroyed a test missile in two minutes. Right: The last thing a kill vehicle ever sees: its target.

Kinetic energy interceptors (left) are MDA's multi-purpose defense missiles. The 36-foot KEI is twice the length of interceptors fired from the Aegis. A sea-based version may be ready by 2013.

ple missiles. But a "rudimentary capability," in Pentagon parlance, is the first step toward an operational system. Obering says the rudimentary system in place now could shoot down a nuke—if it is coming alone.

"Do we have confidence that the system as deployed today could knock down that [Taep'o-dong 2] that was launched last summer?" Obering says. "The answer is 'yes' because we had the sensor coverage, and we had sufficient inventory of interceptors to handle that missile."

He continues: "Now, if the North Koreans had launched 10 or 15 missiles at us in a wave, could the system handle that? That's a different question."

Since late 2004, the Pentagon has been installing interceptors and training soldiers to control them. Brigadier General Patrick O'Reilly, deputy director of the MDA, says the number of interceptors in Alaska could grow to 21 by the year's end and to 40 by 2011.

Obering is counting on new sensors to aid his misson. Among the most powerful will be the 30-story-high, Sea-Based X-band Radar (SBX), an instrument so powerful, he says, it is able to track and image a baseball flying from the Chesapeake Bay to San Francisco (see "How Things Work: Phased Array Radar," June/July 2006).

If SBX works as advertised, it could make Obering's life much easier. "If I can discriminate what precisely is a warhead, I only need to put maybe one interceptor on that target," he says.

In early January, the massive radar steamed north to show it would be able to operate through the famously rough winters along the Aleutian Islands, which are in the likely path of a North Korean missile.

Another headache has been negotiating siting rights for fixed radars, and deciding where they should be built based on intelligence about future threats.

New eyes in space could solve basing problems. Two prototype Space Tracking and Surveillance System satellites built by Northrop Grumman are due to be launched this November. These could pave the way for a constellation of infrared tracking satellites that would provide near global coverage.

SO, CAN THE U.S. STOP A NUKE? The answer, because of limitations on testing, seems to be that no one will know until the threat is inbound.

Missile defense proponents and developers cheered September's success—a single 23-minute test. But U.S. weapons evaluators typically demand hundreds of hours of operation before a tool of war is placed in the hands of soldiers, pilots, or sailors. The missile tests have shown that the smallest detail gone wrong can derail even a well-planned launch.

It takes hundreds of people months to prepare for an intercept test. Says Pat Shanahan, Boeing's vice president in charge of missile defense, radars must be calibrated in advance so that the fire control computer will know: "MD-80s on their way to Mexico, flying down the coast of California—don't shoot those."

Testing may be an intractable problem. That leaves the military in the position of not knowing how the system will work until it is called on to perform. Only if nuclear warheads streak toward the United States will the question finally be answered, with millions of lives in the balance.

U.S. NAVY

The Sea-Based X-band Radar (right) steams forward on its mobile oil rig platform. Missile defense proponents have high hopes that this powerful instrument will be able to pick out warheads from a cloud of debris and decoys.

USAF

An interceptor (right) roars from its silo at Vandenberg Air Force Base, California, during a test last August. More than a dozen are now in Alaska, awaiting targets.

The RESISTAN

In the 1930s, a group of air-minded Oregonians started one of the first homebuilding clubs. Their HQ: a field in Beaverton that eventually became lined with the members' aircraft and hangars (opposite). Here, the pilots and builders banded together against a new threat: federal regulation.

IN 1912, SILAS CHRISTOFFERSON BROUGHT Portland, Oregon, into the age of the airplane. The 24-year-old took off in a Curtiss pusher from the roof of the 12-story Multnomah Hotel, flew for 12 minutes, then set down in Fort Vancouver, on the Washington side of the Columbia River. Thousands of people crowded the streets to see their first airplane flight, and for a few of them, the moment fixed their path through life.

Throughout the early 1900s, small communities of young airplane enthusiasts coalesced around nuclei of designers and personalities scattered across the state. One little group operated, tenuously, from the Rose City racetrack on the eastern edge of Portland. Twenty miles west, near the tiny town of Cornelius, a cadre gathered around designer Les Long, who would later be called the father of homebuilding. Other groups formed about a hundred miles south, in Eugene and Springfield. There was even a gathering in remote Klamath Falls, east of the Cascade Mountains.

But the real heart of grassroots aviation in Oregon began to beat just west of Portland, in the hayfields of Beaverton.

One young Beaverton resident, having heard about Christofferson's plans, walked

five miles from his home to catch a streetcar into Portland, where he joined the crowds craning their necks to get a glimpse of the racketing biplane. Charlie Bernard had been hooked on the idea of flying for quite a while. The streetcar he rode to high school ran past the Adcox School of Aviation, where students were building a very simple glider, launched by an elasticized cord. Bernard, fascinated, often skipped school and spent the day there instead, talking and working with the students. "My heart and soul was in Adcox, not my school," he said in an interview with oral historian John Patton in 1978.

Without his father's permission, he invited the students to the family farm in Beaverton, where they assembled the glider in the barn. Occasionally, Bernard and his saddle horse would substitute for the launch cord, galloping down the sloping pasture and dragging the glider into the air with a rope cinched around the saddle horn. Flights were measured in seconds. If the wind was right, the glider would gain enough altitude to permit a turn and landing. "Sometimes they'd fly a hundred feet, sometimes they'd fly a thousand feet," Bernard said. "It depended on the pilot and the conditions. At any rate, the boys were in the air."

Soon enough Bernard's father became aware of what he considered immature antics in the family hayfield and put a stop to it, insisting that Charlie finish school and prepare himself for a real career. Charlie reluctantly complied, and in 1916 the field closed and the glider disappeared. For the next 12 years he kept his fascination with flying to himself, indulging his mechanical interests by selling cars. When his father died in 1928, he obtained some property from an uncle, not far from the original glider field, and started clearing brush. He had a plan.

Bernard's venture into the car business had acquainted him with the local mechanics, and he was drawn to a garage run by a man named Elmer Stipe. Working for Stipe was George Yates, who would become one of the more talented and innovative aircraft designers and builders in the country. Stipe had become interested in flying, and asked Yates to build an airplane that the two of them could use. Bernard offered them the use of his field—"I was interested in the airplane, I was interested in George Yates, and I was interested in Mr. Stipe, so I built them a hangar." Within weeks, other pilots and aircraft builders began showing up, so Bernard built more hangars along both sides of the field.

Occasionally, the right people come together at the right time and in the right place, and the intersection changes history. In Beaverton, Oregon, in the early decades of the 20th century, the right people banded together to form a new flying movement: a community devoted to homebuilding. It's a structure that survives today, in local clubs where members help one another build and fly aircraft.

By then, the state government had taken notice of all the aircraft design and flying going on throughout the state. "Bill Would Curb Fliers" a page 6 headline had proclaimed in the January 20, 1921 Portland *Oregonian* newspaper. An article the following July noted that "the airplane, in common with the automobile, motorcycle and other vehicles, has been subjected to state regulation under a new law." The governor appointed a pilot examination board, and the state began requiring aircraft to be examined and registered. For $10, the applicant would receive "a number plate, which must be attached and displayed...on the aircraft." It was a fairly relaxed form of regulation, and did not appear to discourage aerial experimentation in Oregon. State license plates began appearing on airplanes of all descriptions.

In Beaverton, the airplane Yates built for Stipe was a two-seat tandem design with a parasol wing. Known as the Stiper, it eventually flew some 4,000 hours, carrying hundreds of passengers and students. Other homebuilt designs began emerging from the hangars. Pilot Johnny Bigelow, one of the Beaverton crowd, recalled in another John Patton interview that "experimenting was absolutely uninhibited and unrestricted. You could have a state inspector come out and license your airplane for a few dollars. This created a climate that was pretty hard to beat, anywhere in the world."

Photographs of Bernard's field during the 1930s bear him out, showing airplanes of all kinds scattered across the 60 acres, the majority of them homebuilt. There were high-wing airplanes, low-wing airplanes, and even one airplane with no wings at all—a design by

CE

When the Feds got in their airspace, Oregon's first homebuilders fought back. by Ken Scott

ALL PHOTOGRAPHS: OREGON AVIATION HISTORICAL SOCIETY

The Civil Aeronautics Authority made it virtually impossible for a pilot to use the majority of airports without flying through federal airspace. To the Outlaws, this was a sky-grab, pure and simple.

Marvin Joy with a halibut-shaped lifting surface and two tiny Salmson radial engines mounted just above the landing gear. (Pilot-mechanic Danny Grecco said he made two brief hops in it and noted, unsurprisingly, that the craft had no lateral stability.) Bigelow himself flew a Heath Parasol, built from plans sold by Ed Heath, who would later become famous for his Heathkits—kits for assembling your own stereos and other electronics. Even though the Henderson motorcycle engine in the nose was supremely unreliable, Bigelow flew the Parasol constantly, excited to be part of the Beaverton gang and the age.

It didn't hurt the cozy world of state-regulated aviation that the state aircraft inspector was an enthusiastic pilot and supporter of amateur-built airplanes. In 1934 Allan Greenwood was appointed to the Oregon State Aeronautics Board, where he was charged with inspecting and licensing airplanes built within the state. Greenwood issued most of the licenses to airplanes built by experimenters and amateurs, some of which had achieved national recognition. Les Long, who had a small airfield on his farm, had published plans for his Longster in *Popular Mechanics*, and, by writing for several aviation publications, had become a prominent voice for "the little fellow." George Yates had established a shop at Bernard's airport, where he produced several airplanes, including a twin-engine design called the BiMotor, all based on his unique basket-weave construction—an immensely strong material made of geodetic woven strips of wood. Another fixture at Bernard's was Walter Rupert, who set national altitude records with his Rupert Special, a parasol monoplane with a Salmson radial engine.

While the government of Oregon had established a climate of tolerance for experimental airplanes, across the rest of the country, the federal government was doing the opposite. The Bureau of Air Commerce, created in 1926, became the first federal agency to take responsibility for certifying civilian aircraft. The bureau wrote provisions for licensing general-purpose aircraft. But the

State regulation required license plates (below) but allowed homebuilding. Middle: Oregon air pioneer Silas Christofferson. Right: Bernard's field, starting to show nearby development.

Above: Walt Rupert (left) and Charlie Bernard. Opposite: George Yates and his BiMotor; middle: Yates' hangar.

closest thing it had to a classification for one-of-a-kind designs was an experimental category, NX, granting manufacturers a 30-day period to test new models. As for homebuilt aircraft, they could not be registered. In 1938, the bureau became the Civil Aeronautics Authority (ancestor of the present Federal Aviation Administration) and began to inspect, regulate, and register airplanes with new energy.

In Oregon, the flying communities met CAA inspectors with everything from polite indifference to outright aggression. When a federal inspector showed up at the Hillsboro airport incognito, flight service operator Ed Ball knew immediately whom he was dealing with. Ball and his designing partner, Swede Ralston, had registered their airplanes with the CAA, but Ralston had friends who were still operating with only state licenses and registrations. A chuckling Charlie Bernard told John Patton what happened next: "Ed called and told me he was sure this fellow was headed for Beaverton to catch unlicensed pilots. When he showed up, I acted like I didn't know who he was. He wanted to buy a ride, he said, and when I showed him one of the [federally legal] airplanes he said no, he didn't want to ride in that, he wanted to ride in that pretty yellow one. Then he wanted to take pictures. I pointed him out to George Yates. George was a powerful man, and he put one hand on this fellow's collar and the other on his belt, took him off the field, and told him he could take all the pictures he wanted from the public road, but he couldn't come back on to the airport."

One of the techniques the Department of Commerce used to force pilots into the federal fold—one that really irritated Beaverton's state-licensed pilots—was to establish "commercial air lanes" between most of the larger airports. An air lane comprised 10 miles on either side of a line connecting two airports; any aircraft within it was subject to federal regulation. The 20-mile width of the lanes made it virtually impossible for a pilot to use the majority of airports without flying through federal airspace.

To the pilots of Bernard's field, this was a sky-grab, pure and simple. The airmen, who would become known as the Beaverton Outlaws, felt that as long as they stayed within Oregon, they did not need regulating by the federal government, so they flew as much as they could while avoiding anybody that looked like a federal inspector. George Yates did his part. Yates was almost always at his hangar on the north end of Bernard's and normally kept the doors open year-

George Yates normally kept his hangar open, but if a federal inspector appeared, he would close the doors. An approaching pilot with an unregistered aircraft would get the message and go someplace else to land.

round. If a federal inspector appeared, Yates would quietly close the hangar doors, and any approaching pilot with an unregistered aircraft would get the message and go someplace else to land.

The Outlaws also faced threats from within their own state. In October 1939, Republican governor Charles Sprague fired Greenwood for the sin of serving as president of the state's Young Democrats. When the state aeronautics board adopted a resolution praising Greenwood's service and granting him another month's salary, the governor sacked the board members too. "The attitude...of the Board shows a lack of cooperation I will not tolerate," Sprague snarled in a press release. "I shall ask the reorganized Board to make a fresh study to determine how much need there is for a State Inspector or Director of Aeronautics."

One of those appointed to the new board was Salem businessman and aviator Lee Eyerly. Eyerly was starting a company to produce a small airplane based on a Les Long design, so he was vitally interested in the question of how aircraft were to be licensed within the state. Early in his tenure he met with federal officials. In February 1940, he sent a letter to Sprague, describing a meeting with a Mr. Walker and E.B. Cole, CAA authorities from Washington, D.C. "[They] accompanied us to the Beaverton airport," wrote Eyerly. "[T]hey let it be known that it was their wish that we fall in line with their regulations; but after showing them our side of the picture, Mr. Cole seemed somewhat perplexed...an alternative suggested by both Mr. Cole and the Board was for the CAA to cite some individual for a violation and make a test case of it to determine whether the CAA or the State holds jurisdiction over intrastate flying."

A month later, Harold Wagner and Donald Wray, both licensed by the state of Oregon, became Eyerly's case. They took off from Bernard's, which was one end of the shortest airmail route in the country—the 15-mile Portland-to-Beaverton trip—and thus part of an air lane. Both were promptly issued citations and fined $100.

Late in 1940 the case went to court. But before it could be resolved, Pearl Harbor was attacked.

After the United States entered World War II, the federal government decided that small aircraft flying in U.S. airspace without radios posed a threat, since they could not always be readily identified as friend or foe. Civilian aircraft were tucked away in hangars, barns, and garages. The test case trickled through the court system until 1942, when it was quietly dismissed.

The Outlaws felt that as long as they stayed in Oregon, they did not need federal regulating, so they flew as much as they could, while avoiding anybody looking like a federal inspector.

After the war, the Outlaws made one last attempt to regain their early freedoms. In 1946, George Bogardus, who had flown from Bernard's before the war, resurrected a small single-seat air-

Below: The work of Beaverton's Eugene Cooper, this aircraft had engine valve covers marked, mysteriously, "Groat." Opposite: The Student Prince, a design built by a later version of the Adcox flying school.

Opposite: Could this dubious Salmson-powered design fly? One Beaverton pilot claimed he got it airborne, twice. Below: The Rupert Special buzzes Bernard's field. Right: The rising fortunes of the neighborhood would doom the airpark.

plane that Lee Eyerly had commissioned as a prototype. Bogardus brought it back to flying condition and dubbed it *Little GeeBee*, perhaps after his initials (see "Barnstorming the Beltway," Restoration, Apr./May 2006). In 1947, supported by coins, crumpled dollars, and lodging donated by fellow Oregonian pilots, Bogardus flew *Little GeeBee* across the country to take the case for amateur-built aircraft to Washington, D.C. There he lobbied the CAA on the importance of protecting the category of homebuilt aircraft from being regulated out of existence. Four years later, he made another such trip, and finally, the CAA wrote a regulation that permitted Americans to build their own airplanes and, after an inspection, license them in an "experimental" category—a plan very much like Oregon's system. (For his efforts, Bogardus later became one of the first three people inducted into the Experimental Aircraft Association's Homebuilders Hall of Fame. His *Little GeeBee* is now owned by the National Air and Space Museum, and it will be displayed later this year at the Museum's Steven F. Udvar-Hazy Center in northern Virginia.)

Les Long's airfield eventually reverted to farmland, although the current owner still works in the Outlaw-era buildings there and flies his Piper PA-11 from a short grass strip on the edge of the property. Ed Ball and Swede Ralston developed Hillsboro into a major regional airport, where Ralston, now 90, still comes to work every weekday—his office overlooks a large ramp filled with his charter company's multi-million-dollar jets.

Charlie Bernard's airport succumbed to economic necessity in 1969. Surrounded by residential and commercial development, the property became so valuable that hangar rents could no longer pay the taxes and expenses. Bernard sold the land to shopping mall developers, and drove his own bulldozer to knock down the hangars he'd built board by board almost 40 years earlier. Walt Rupert, who had flown and had operated a flying service at Bernard's from the first day to the last, couldn't bear to watch.

In 1978, John Patton asked Bernard how it had felt to put the blade against the hangars. Bernard paused for a long time, then said, "Did you ever want to cry, but the tears just wouldn't come?" He died the following year.

Today, the Experimental category is one of the most vibrant of American aviation. Several hundred new amateur-built airplanes are registered—federally, of course—in the United States every year. An entire industry has evolved to supply homebuilders with kits, materials, and parts. The Oshkosh, Wisconsin-based Experimental Aircraft Association—Homebuilder Central—has 921 chapters across the United States, and dozens more in other nations. The Outlaws, says Carol Skinner, archivist of the Oregon Aviation Historical Society, "paved the way for pilots who could not afford production aircraft but wanted to have their own."

Fittingly enough, today, some of the largest companies in the homebuilding field, such as Van's Aircraft and Lancair, are based in Oregon—almost in the shadow of Bernard's airport.

LOOKING FOR LIFE

BY CHRISTEN BROWNLEE
ILLUSTRATION BY RICHARD THOMPSON

IN 1976, SCIENTISTS ANXIOUSLY waited for the first data streaming back from the Viking 1 and 2 landers, sent to search for signs of life on Mars. The results were frustratingly inconclusive; for decades researchers have been debating whether the Vikings detected life. Then last January, two scientists presented a paper arguing that Mars may indeed harbor life, but that the landers' life-detecting equipment may have killed it. They theorized that Martian microorganisms might contain a mixture of water and hydrogen peroxide; if so, a Viking experiment that doused Martian soil samples with water would have drowned such life-forms.

The idea that Mars may harbor microbes containing hydrogen peroxide is based in part on the presence of what appears to be that chemical on Mars' surface. The theory that microbes may be the origin of that hydrogen peroxide is not well accepted—not yet, anyway. Most researchers digging for extraterrestrial life are focused on forms containing water and carbon-based molecules—the only forms found on Earth. But a growing number of scientists are speculating that the solar system may harbor what they call "weird life"—forms that contain chemicals not traditionally associated with living organisms.

Thanks to the discovery of unusual creatures on Earth, such as "extremophile" bacteria adapted to the extreme heat of underwater thermal vents, most astrobiologists accept the possibility that life-forms on other planets could have unfamiliar appearances or adaptations. However, most still envision microbes filled with water and carbon-based, or organic, molecules. It's not unreasonable, says David Grinspoon, astrobiology curator of the Denver Museum of Nature and Science and formerly NASA's principal investigator for exobiology research. He points out that such compounds have been detected in practically every corner of the universe that has been examined.

However, he and other researchers now suggest that an element other than carbon may serve as the backbone for molecules essential to life-forms on other planets. One proposed substitute is silicon, which occupies a place on the periodic table directly under carbon. Vertical rows on the table represent an element's most basic behavior, so carbon and silicon's close positions suggest that one can be swapped for another to form molecules with similar characteristics, says Grinspoon.

Likewise, water isn't the only solvent that life-forms could use to enable necessary chemical reactions, says Dirk Schulze-Makuch of Washington State University in Pullman, one of the scientists who suggested that Viking may have killed Martian microbes. "Life and environmental conditions on a planet are intrinsically related," he explains; he champions the idea of Martian organisms containing hydrogen peroxide because it fits with the very cold and dry conditions on that planet. Depending on its concentration in a solution, hydrogen peroxide does not freeze until at –70 degrees Fahrenheit, and when it does freeze, it does not form crystals, which would destroy cells . And the compound absorbs even minute amounts of water vapor from the atmosphere, which would benefit a water-dependent organism in an extremely dry environment like Mars'.

Chemist Steven Benner of the University of Florida in Gainesville suggests that the molecules that might make up weird life and

IN ALL THE WRONG PLACES

WOULD WE KNOW EXTRATERRESTRIALS IF WE SAW THEM?

enable it to reproduce may differ from terrestrial proteins and the nucleic acids DNA and RNA. By making some simple chemical tweaks to these molecules, Benner and his colleagues have crafted new variations that still work. "You can pick any one of these [molecules] and easily walk away from its natural structure" while still preserving functionality, he says. Benner and other researchers have come up with a variety of new amino acids, the molecules that string together to form proteins, that don't exist in nature—at least not on Earth. His group has also constructed new types of DNA with bases different from the adenine, thymine, guanine, and cytosine that form the rungs in the double helix on Earth.

The probes that search for life on other planets use technology that can detect a range of chemicals beyond water and organic molecules. The trick is to devise experimental protocols that do not destroy or miss signs of possible life—a protocol, for example, that does not douse samples with water if hydrogen peroxide is thought to be a possible constituent. Recently, Rafael Navarro-Gonzalez of the University of Mexico in Mexico City and others decided to check the instrument that Viking used to test Martian soil for organic molecules, a gas chromatograph–mass spectrometer (GCMS), which identifies the atomic constituents of a substance. The scientists used the instrument to test soils from areas on Earth that are similar to Mars and known to have organic molecules, but it nonetheless gave negative readings, again casting doubts on Viking's results. Navarro-Gonzalez says that the Mars Science Laboratory, presently planned to launch in two years, will also use a GCMS, but it will follow a different sample-treatment protocol, one that uses solvents, and is more likely to reveal organic molecules, if any are present.

Another way to increase the chances for finding new life-forms is to send probes to areas where they are more likely to be found—that is, to search creatively. The Mars Science Laboratory will cover a much greater area than Viking did. And NASA's Phoenix probe, currently scheduled to take off this August, will land in a subpolar area of Mars that is especially cold and higher in atmospheric water vapor—more favorable than the Viking sites for detecting life, especially the hydrogen peroxide-containing organisms Schulze-Makuch envisions. Phoenix will also carry nonchemical tests: two microscopes to study samples for signs of life.

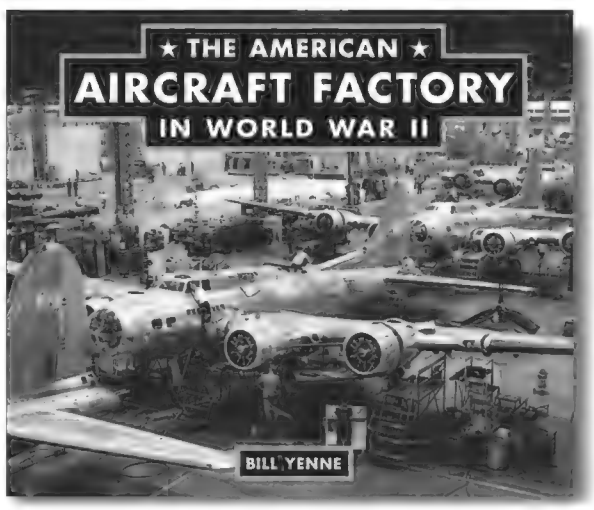
What's the probability that life unlike anything we know is thriving in extraterrestrial obscurity? "The chances that it might exist are high, but the chances that we're going to encounter it are probably low," says Benner. "Space is a big place." To plan a search that has a decent chance of finding whatever may be out there, we will need not just technology but imagination.

"Fundamentally," says David Grinspoon, "the universe is much more creative than we are."

300,000 Airplanes

A salute to the aesthetics of war production.

IN 1939, U.S. AIRCRAFT FACTORIES MANUFACTURED 921 warplanes. By 1944, the annual output was a staggering 96,318 units. Total U.S. wartime production of military aircraft surpassed 300,000. A new book, *The American Aircraft Factory in World War II* (Zenith Press, 2006), documents the industry's transformation from an enterprise of craftsmen building airplanes by hand to a powerhouse of men and women toiling with assembly-line efficiency. "The aircraft manufacturers were dedicated to engineering and manufacturing excellence, but arguably no more so than they are today," says the book's author, Bill Yenne. "What happened was that the whole nation came together for a single purpose, and successfully committed itself to doing all that was necessary. All aspects of what the United States did during World War II, both at home and on the global battlefronts, were unlike anything before or since."



BOEING ARCHIVES

Over the years, Yenne has written histories of the great U.S. airplane makers, including Boeing, Convair, Lockheed, McDonnell Douglas, and North American Aviation. "While doing this, I was time and again amazed by their Herculean wartime effort," he says. "This book gave me an opportunity to tell the story in both words and pictures." In addition to Yenne's meticulously researched text, the book offers 175 photographs, many of them candid black-and-white images that reveal the sculptural beauty of airplane parts precisely arrayed on factory floors. The book also has plenty of posed, beautifully lit color photographs of workers on production lines.

The federal government's Office of War Information and company photographers made the images in an effort to publicize the war effort. In Yenne's book, they remind us that the work was not just an exercise in patriotism, but a giant step forward in transforming aviation into one of America's biggest industries.

—The editors

★★★ OVERHEAD LIGHTS AT A factory in Santa Monica, California, are reflected in row upon row of Plexiglas noses destined for Douglas A-20 attack bombers.

★★★ **A TECHNICIAN AT VEGA AIRCRAFT** in Burbank, California, inspects electrical subassemblies probably destined for U.S. Navy PV-1 Ventura patrol aircraft. When the Office of War Information released this photograph, it was accompanied by a caption that read in part, "Hollywood missed a good bet when they overlooked this attractive aircraft worker."

LEFT: DAVID BRANSBY/OFFICE OF WAR INFORMATION; TOP: COURTESY HARRY GANN

BILL YENNE COLLECTION

★★★ **BUILT AT FACTORIES IN CONNECTICUT,** New York, and Illinois, Pratt & Whitney R1830 Twin Wasp radial engines were shipped to California to power Douglas C-47 transports. These two dozen Twin Wasps were among more than 173,000 built between 1932 and 1951.

★★★ **A WORKER AT VULTEE'S NASHVILLE,** Tennessee factory makes final adjustments in the wheel well of an inner wing before the installation of landing gear — one of the numerous assembly operations in the production of Vengeance dive bombers.

ALFRED PALMER/OFFICE OF WAR INFORMATION

COURTESY HARRY GANN

★★★ **WORKERS AT THE DOUGLAS** factory in Long Beach, California, prepare a Boeing B-17 Flying Fortress fuselage near what will be the waist gun positions. Douglas built B-17s as part of the Boeing-Douglas-Vega committee, which pooled production resources.

BILL YENNE COLLECTION

★★★ **LOOKING DAPPER** in a tie and vest, a Consolidated welder fashions an airplane part. Even as late as the 1930s, many critical parts for the company's aircraft were made by hand. Both the technology and the dress code would change.

★★★ **STAFF AT THE NORTH AMERICAN AVIATION** plant in Inglewood, California, observe a scale model of a B-25 Mitchell bomber in wind tunnel tests (right). On April 18, 1942, 16 B-25s took off from the aircraft carrier *Hornet* and, led by Jimmy Doolittle, raided the Japanese mainland.

ALFRED PALMER/OFFICE OF WAR INFORMATION (2)

★★★ **DOUGLAS TECHNICIANS READY** a Pratt & Whitney radial engine for installation in a C-47 transport at Long Beach.

BOEING ARCHIVES

★★★ **DOZENS OF B-17 AFT FUSELAGE/TAIL SECTIONS** crowd Shop 308 of Boeing's Plant 2 in Seattle, Washington. During the war, the bombers earned a reputation for flying on even after sustaining heavy damage.

The MOOSE JAW NINE

Why the Canadian Snowbirds always steal the airshow. >>> by Graham Chandler

I'M IN THE LEFT SEAT of Snowbird No. 4's aircraft as the team practices an arrowhead loop formation over a flat January landscape the color of faded wheat near its home base of Moose Jaw, Saskatchewan. On the pullup and during the float over the top, I keep an eye on Snowbird No. 8, Captain Mark LaVerdiere, the outer wing man, three airplanes away on my left. He maintains his position but there's a bit more movement than I'm seeing from the aircraft to my immediate left. As we come down the back side, with the call "Power coming up" from the lead aircraft, I try to picture what it must be like keeping LaVerdiere's outer wing position in a nine-aircraft line-abreast formation. Like the end of a crack-the-whip.

I'm flying with Captain Dave Boudreau, who is the first line-astern position with Canada's 431 Air Demonstration Squadron, better known as the Snowbirds. It's the first half of practice season, and the team hasn't yet worked up to its nine-airplane formations. But when it does, airshow announcers could well alert the crowds with the Monty Python introduction: "And now for something completely different."

The Snowbirds don't even try to mimic their U.S. counterparts, the Navy's Blue Angels and the Air Force's Thunderbirds, who fly top-of-the-line jet fighters. There are no high subsonic afterburner-blasting passes; Snowbird performances aren't about blinding speed and chest-thumping military might. They're designed, quite simply, to keep the crowds entranced with their formation routines.

The team is as distinctly Canadian as the "snowbirds," the northern folk who flock

ERIK HILDEBRANDT

The Snowbirds generally fly more slowly than their U.S. counterparts, which gives the crowds a good, long look at dense formations like Big Diamond (above).

MIKE SROKA

After each performance, pilots and technicians debrief over the wing of Snowbird No. 5 before meeting their fans.

to Florida and other warm points south each winter. "When I was a kid I had two goals," says LaVerdiere. "One was to be an NHL hockey player and the other was to be a Snowbird pilot." Most Canadians view the Snowbirds as a national icon, part of the country's character. "When you talk to people after shows in Canada, you'd be surprised at how many don't know we're a military organization," says Major Cory Blakely, Snowbird No. 3, inner left wing. "In a large way, they identify us as a truly Canadian thing."

As the Snowbirds charge into their 37th season this year, their airplanes don't look or even feel old. The primary jet trainers are built solid enough to withstand student overstressing and mishandling, and they're extremely well maintained, spotless, and beloved.

Designed by Canadair in the late 1950s, the CT-114 Tutor first flew on January 13, 1960—well before the elders of today's fighter community, the F-16s and F/A-18s, were even on a drawing board. Yet the Tutors may continue delighting the crowds until 2023, says the Bombardier company, which now owns Canadair. No longer operational as air force pilot trainers—they were replaced in 2000 by Raytheon CT-156 Harvard IIs and BAE Systems CT-155 Hawks—most of the 190 that were built are used to train maintenance teams. "It was an ideal [pilot] trainer because of the forgiving handling characteristics and excellent slow-speed qualities," says Blakely, who trained in the Tutor and is now in his fourth year as a Snowbird. "It affords the ability to fly at higher speeds for transition to higher-performance aircraft, and it's a very good aerobatic airplane." He says the side-by-side seating allows a clearer explanation of instrument flying than front and back seating. "By the same token, it's an excellent training aircraft for new Snowbird pilots," he adds, "allowing the instructor Snowbird to make direct observation of the control inputs of the fledgling Snowbird."

There are no high subsonic afterburner-blasting passes; Snowbird performances aren't about blinding speed and chest-thumping military might. They're designed simply to entrance the crowds with their formation routines.

The Tutor can turn on the proverbial dime, and it needs only 4,000 feet of runway, so the team can perform at remote villages like Fort Smith, Northwest Territories, population 2,600. "The Tutor is perfect for formation flying—low power and a great roll rate," says Blakely. "So we can keep it tight and right in front of the crowd. Unlike a fighter, we can get turned around pretty quick." Which doesn't go unnoticed by other teams.

"What's impressive to me is seeing all those nine aircraft flying in a delta formation or flying in a line-abreast formation," says Lieutenant Commander Anthony Walley, Blue Angel No. 2. "I mean, that is incredible. Since it's a smaller aircraft, they can really get into some tight formations, and from the crowd's perspective it looks like they're right on top of each other."

With the smaller, more nimble airplanes, Walley says, Snowbird pilots can take advantage of the tighter turn ra-

The Big Arrow formation coasts over the top of a loop while the pilots hang in their harnesses in near-zero-G (below); positive Gs push them into their seats in the Downward Burst (opposite).

LEFT: KEN LIN; OPPOSITE: MIKE SROKA

The Snowbirds' 2007 Schedule

ALBERTA, CANADA
Calgary, July 6
Calgary Stampede Flypast
Camrose, Aug. 2
Camrose Air Show
Edmonton, July 22
Edmonton Grand Prix Flypast
Fort McMurray, July 21
Fort McMurray Air Show
Lethbridge, Aug. 4 & 5
Lethbridge Air Show
Peace River, July 28 & 29
Peace River Air Show

ARKANSAS, U.S.A.
Fayetteville, Sept. 26
Arkansas Air Museum AirFest

BRITISH COLUMBIA, CANADA
Abbotsford, Aug. 10–12
Abbotsford Air Show
Fort St. John, July 25
Fort St. John Air Show
Kelowna, Aug. 15
Snowbirds Fly for CHILD
Penticton, May 23
Penticton Air Show

CALIFORNIA, U.S.A.
Salinas, Sept. 29 & 30
California International Air Show

INDIANA, U.S.A.
Evansville, July 4
Evansville Fourth of July Air Show

MANITOBA, CANADA
Brandon, May 26 & 27
Brandon Air Show
Portage-La Prairie, June 2 & 3
Portage-La Prairie Air Show
The Pas, July 18
The Pas Air Show

MONTANA, U.S.A.
Malmstrom AFB, May 19 & 20
Malmstrom Air Show

NEVADA, U.S.A.
Reno, Sept. 14–16
National Championship Air Races

NEW BRUNSWICK, CANADA
Dalhousie, June 13
Dalhousie Air Show
Moncton, June 16 & 17
Moncton Air Show

NEW MEXICO, U.S.A.
Tucumcari, Sept. 19
Tucumcari Rotary Club –
60 Years of the Air Force

NOVA SCOTIA, CANADA
Halifax, Sept. 8 & 9
Halifax Air Show

ONTARIO, CANADA
Cobourg, June 30
Cobourg Air Show
Kapuskasing, June 6
Kapuskasing Air Show
Kingston, June 27
Kingston Air Show
Ottawa, July 1
Canada Day Flypast
Owen Sound, June 20
Owen Sound Air Show
St. Catharines, Aug. 25 & 26
St. Catharines Air Show
St. Thomas, June 23 & 24
St. Thomas Air Show
Toronto, Sept. 1–3
Canadian International Air Show
Toronto, Sept. 4
Flypast of the Captain Michael VandenBos School

QUEBEC, CANADA
Bagotville, June 9 & 10
Bagotville Air Show
Candiac, Aug. 29
Candiac Air Show

SASKATCHEWAN, CANADA
Moose Jaw, Oct. 12
Year-End Show
Saskatoon, Aug. 18
Saskatoon Air Show

TENNESSEE, U.S.A.
Millington, Sept. 22 & 23
MidSouth Air Show

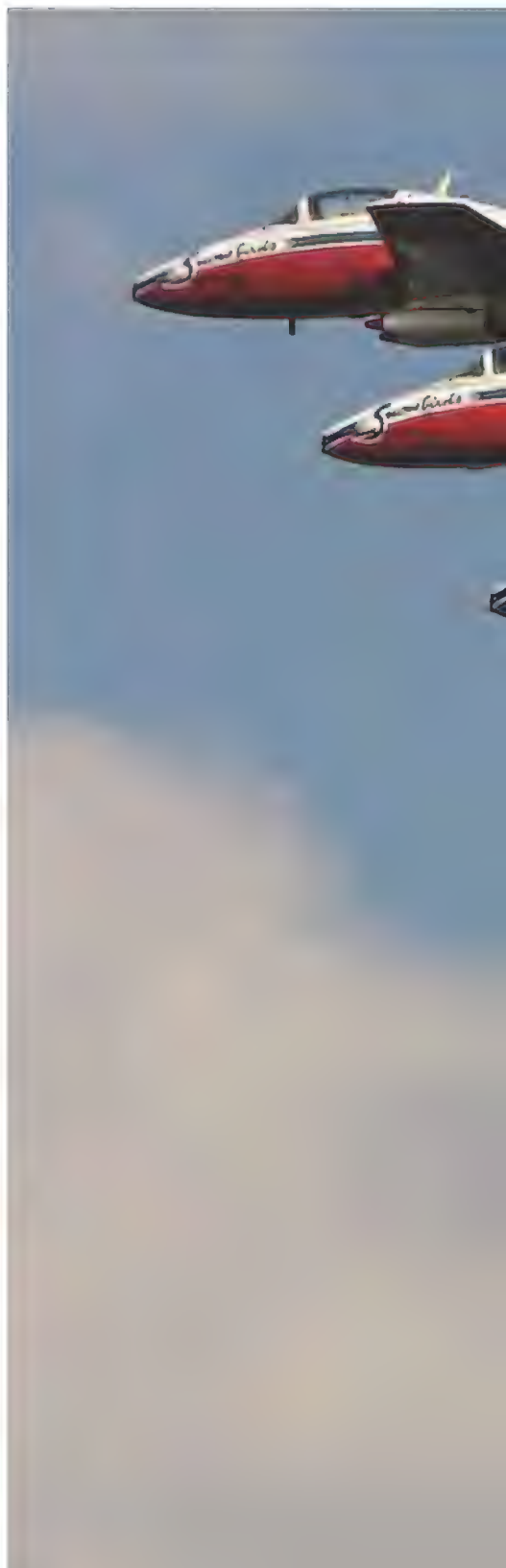
TEXAS, U.S.A.
Houston, Oct. 6 & 7
Wings Over Houston

Schedule provided by Canada Department of National Defence as of Feb. 1, 2007. Check local listings.

dius. "You can do a lot more of your transitions and formation changes in front of the crowd," he says. "For whatever reason, we've always done our formation changes behind the crowd. I think one of the reasons now is that the F-18 just doesn't have as tight a turn radius as the Tutor."

The slow speed and tight formations of the nine Tutors give the Snowbirds a different combination of options. The team used to do nine-airplane formation takeoffs and landings, but Blakely says these difficult maneuvers have been shelved, "based on a 'risk versus reward' analysis. The takeoff-and-landing runway is not always aligned with or visible to the crowd, so exposing the aircrew to elevated risk was deemed unnecessary."

Still, the team likes to open and close with nine-airplane maneuvers. "It can be difficult to get the nine-plane together once it's apart," Blakely explains. "The opener [segment] will typically be about 12 minutes long and will usually involve two or three loops or rolls in the nine-plane formation. In between those rolls, there's a presentation of either a bottom side pass [presenting the aircraft underside to the show line] or a top side pass as we go by in some different formation, like a nine-plane line-



Captain Ian James, Snowbird No. 12, flies over British Columbia's Comox airport, the team's practice site every April.

KEN LIN

abreast. The closer is somewhat shorter, and again involves two or three loops."

The nine-airplane line-abreast looks straightforward, but "any time you add more aircraft on anyone's wing on a line-abreast maneuver, you're increasing the difficulty," says Blue Angel Walley. "More so for the the guys on the outside, because you have to look through the movement of the guys on the inside, and still try and maintain your position on the [lead aircraft] best you can."

The Tutor lacks the high thrust-to-weight ratios of the U.S. teams' aircraft. The Canadian team compensates with creative flying techniques. "We're always power-critical," says Blakely. "So we tailor our profiles to those thrust limitations. On a hot day in a high-density altitude, we really earn our money staying in formation, particularly the guys on the outside and the second line-astern." (The higher the terrain and the hotter the temperature, the thinner the air, which results in a decrease in aircraft performance.) He explains how they take advantage of a visual illusion. "Our line-astern guys are stacked underneath the boss, so the second guy is a good 20 feet outside the turn radius of the inner plane when they pull up into a loop. On a high and hot day, he'll probably not have enough power to maintain his position all the way around a standard loop." Blakely explains that those pilots will slide their aircraft forward un-

Major Cory Blakely, Snowbird No. 3 (right), says the Tutors excel at formations – such as the signature nine-airplane line-abreast (below) – because of their relatively low power and high roll rate.

LEFT: MIKE SROKA; BELOW: TYSON RININGER

The signature formation trades salutes with team technicians at the September 2006 Redding Air Show in California.

til the nose of one overlaps the tail of the other. "We call this vertical stacking," he says. "That geometric difference allows them to have enough power to stay all the way around and be basically all overlapped on the back side of the loop."

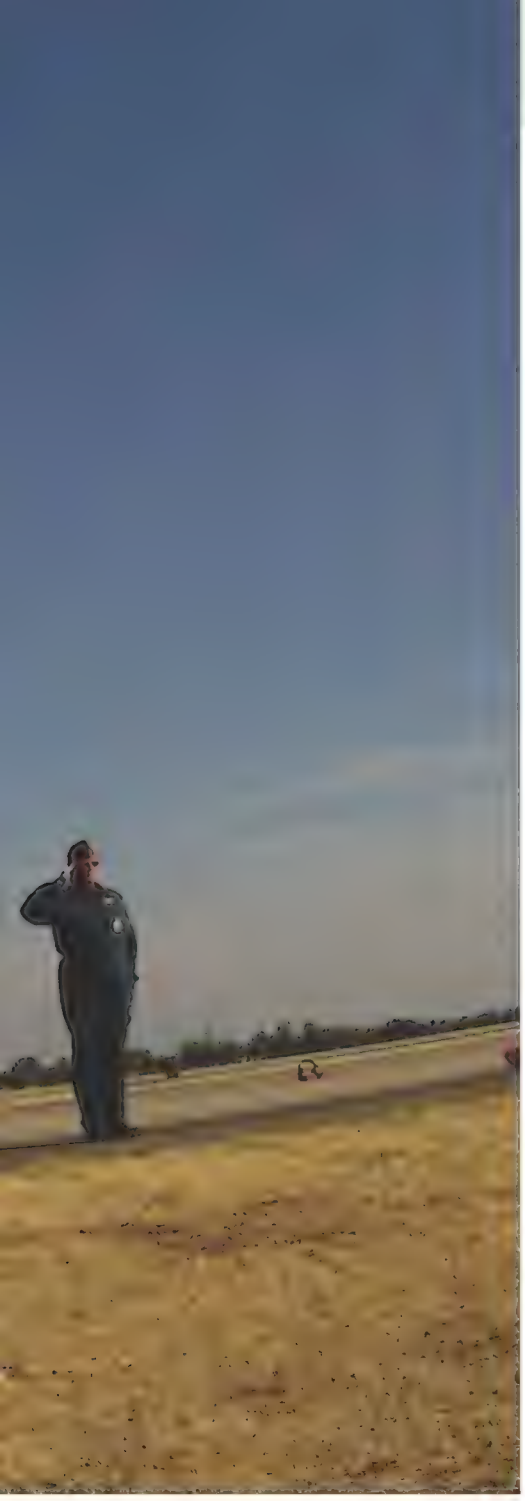
Another Tutor restriction is credited with creating one of the Snowbirds' unique maneuvers, the Double Take. It came about as a direct result of an engine limitation. The aircraft can be flown inverted for a maximum of 20 seconds before G forces hamper fuel flow. (Current U.S. fighters can manage for 30 to 60 seconds.) Starting in a four-airplane diamond formation, the lead and the first line-astern are right side up, and the inner pilots roll upside down. As they fly past the crowd, the entire formation rolls through 180 degrees so that the inner pilots are right side up. A simple non-rolling flyby would take longer than 20 seconds; rolling through 180 degrees allows them to beat the restriction.

"It's one of my favorites," says Blakely, "but also the most difficult. First, flying upside down means reversing the controls—if you want to turn left, you move the stick right, and vice versa—and it really takes quite a while to train your brain for that process. The second thing is when we roll around, you have to actually push 2 negative G. Now you're maintaining formation with reversed controls as the world is spinning around at minus 2 Gs."

Snowbird pilots use heavy nose-down trim when performing difficult maneuvers, especially when in turbulence. Holding back pressure on the stick stabilizes the right arm, enabling a pilot to maneuver using only pressure instead of large movements. The Blue Angels don't have that luxury. LaVerdiere, who flew Hornets, says, "With the F-18 you can't—the computer will con-

MIKE SROKA

Snowbirds No. 10 and 11 (backs to camera) shepherd the Tutors to their parking positions and greet arriving team members. They also narrate performances, alerting crowds to gasp-inducing maneuvers like the Four-Way Cross (opposite).



LEFT: RAFE TOMSETT; BELOW: KEN LIN

until the end of November," he says. "You sit in the background, listen, learn, ask questions, and study. Once you find out what position you'll fly, you shadow the individual you're going to be filling in for. It's a humbling process." Come November, "the old guys leave and you jump into the mix."

Arrival at Moose Jaw was different for new Snowbird opposing solo Mark LaVerdiere. Being a fighter pilot was almost a disadvantage: His squadron was a little short on pilots and was hesitant to release him from flying F/A-18s for a few years.

The Snowbirds select two candidates for each new position, so LaVerdiere had a competition to sweat through first. "You fly with all the team members and they assess you," he says. "Nine flying days, two and three times a day." Candidates must record their own errors each flight. "You focus on your own mistakes for two weeks," he says. On the 10th day a winner is announced.

LaVerdiere is now a member of a squadron that consists of just 20 aircraft and 85 pilots and technicians. Unique to the Snowbirds, the technicians travel from show to show in the nine show aircraft, alongside the pilots. "It's the most amazing thing to be able to travel in that role," says Sergeant Marlene Shillingford, the Snowbird's new crew chief. "Being in the same airplane, having all the formation around you, is a great advantage. We usually fly three aircraft at a time, 10 minutes apart—the coordinator flies in the first group so he's there on the ground first at the airshow site."

There's no support airplane like the Blue Angels' C-130 Hercules *Fat Albert*. Spares travel in a truck called the Mobile Support Vehicle. "We carry most of our parts and tools in the MSV, including two spare engines," says Shillingford. She says her crew can change an engine in four hours.

And those parts, one might think, would be hard to find today. But "we've never been short an airplane for a show due to unserviceabilities or parts shortage," Shillingford says. The lowest-time Snowbird Tutor has just 6,500 hours; it could yet go a long way. The squadron's highest-time aircraft has logged well over 12,500.

The team will perform at eight U.S. sites this year (see p. 44). A U.S. Snowbird appearance guarantees huge crowds, who are as thrilled as the Canadians by the nine little jets, all in a row.

"What's impressive to me is seeing all those nine aircraft flying in a delta formation or in a line-abreast formation," says Lieutenant Commander Anthony Walley, Blue Angel No. 2. "I mean, that is incredible."

stantly override you trying to do that, so my hat's off to them."

Unlike U.S. military team performers, who are fighter pilots, the Snowbirds hail from all walks of military flying. Two of the current team flew Sea King helicopters. Boudreau flew Aurora maritime patrol aircraft, a version of the Lockheed P-3 Orion. Still, the average Snowbird pilot is 36, close to his U.S. counterpart's age.

When Walley showed up at the Blue Angels in September 2005, he had already been selected for the 2006 team. "You still have the existing year's team at several airshows

FIND OUT MORE

www.airspacemag.com

MORE PHOTOS accompany an excerpt from *Snowbirds: Behind the Scenes With Canada's Air Demonstration Team* by writer and photographer Mike Sroka.

AIRSHOWS 2007

U.S. SHOW SCHEDULE

ALABAMA

Birmingham, Sept. 29 & 30
Wings & Wheels

ARIZONA

Kingman, Oct. 6 & 7
Kingman Air and Auto Show

Prescott, Oct. 6
Arizona Skyfest – Defenders of the Skies

Window Rock, Sept. 8 & 9
Window Rock Air Show

ARKANSAS

Fayetteville, June 26
Arkansas Air Museum AirFest (Snowbirds)

West Memphis, May 31 & June 1
West Memphis Air Races

CALIFORNIA

Camarillo, Aug. 18 & 19
Camarillo Air Show

Chico, Sept. 1
Chico AirFest

Chino, May 19 & 20
Planes of Fame Air Show

Fresno, June 16
KJWL Father's Day Air Show & Fly-In

Half Moon Bay, Apr. 29
Pacific Coast Dream Machines

Hemet Ryan, June 9
Hemet Ryan Air Show

Hesperia, Sept. 15
Hesperia Air Show

Los Angeles, June 23
American Heroes Air Show

Marysville, June 29–July 1
Golden West EAA Regional Fly-In & Air Show

Merced, June 2–4
West Coast Antique Fly-In

Modesto, May 12
Modesto Air Show

Pittsburg, Sept. 8 & 9
Pittsburg Sea/Air Fest

Pt. Mugu, Mar. 31 & Apr. 1
Pt. Mugu Air Show (Thunderbirds)

Ramona, June 23 & 24
Ramona Air Fair

Riverside, Mar. 31
Riverside Air Show

Riverside, Aug. 11
Neighborhood Leaders to National Heroes

Sacramento, June 9 & 10
California Capital Air Show (Thunderbirds)

Salinas, Sept. 29 & 30
California International Air Show (Blue Angels, Snowbirds)

San Carlos, June 16
Vertical Challenge Helicopter Air Show

San Diego, Oct. 13 & 14
MCAS Miramar Air Show (Thunderbirds)

San Francisco, Oct. 6 & 7
San Francisco Fleet Week (Blue Angels)

Santa Maria, Aug. 24 & 25
Thunder Over the Valley

Santa Rosa, Aug. 18 & 19
Wings Over Wine Country

Shafter, Apr. 21
Warbirds in Action

South Lake Tahoe, Aug. 25
Lake in the Sky Air Show

Thermal, Nov. 3
Jacqueline Cochran Air Show

Travis AFB, June 9 & 10
Travis Air Expo

Truckee, June 24
Truckee Air Show

Watsonville, May 26 & 27
Watsonville Fly-In & Air Show

COLORADO

Akron, Sept. 8
National Radial Engine Exhibition

Broomfield, June 9 & 10
Jeffco Airport Annual Open House

Denver, June 23 & 24
Front Range Air Show

Pueblo, Aug. 11 & 12
In Their Honor Air Show

FLORIDA

Cape Canaveral, Nov. 3 & 4
NASA Cape Canaveral Air Show (Thunderbirds)

Eglin AFB, Apr. 14 & 15
Eglin Open House Air Show

Ft. Lauderdale, May 5 & 6
McDonald's Air & Sea Show (Thunderbirds)

Gainesville, Apr. 14 & 15
Heart of Florida Air Show

Gainesville, May 19
American Heroes Air Show

Jacksonville Beach, Nov. 3 & 4
Jacksonville Sea & Sky Spectacular (Blue Angels)

Lakeland, Apr. 17–23
Sun 'n Fun Fly-In

MacDill AFB, Mar. 31 & Apr. 1
MacDill AirFest (Blue Angels)

NAS Pensacola, Nov. 9 & 10
Blue Angels Homecoming (Blue Angels)

Pensacola Beach, July 21
Pensacola Beach Air Show (Blue Angels)

St. Petersburg, Oct. 20 & 21
St. Petersburg AirFest

Stuart, Nov. 10 & 11
Stuart Air Show

GEORGIA

Atlanta, June 2
Good Neighbor Day Air Show

Canton, Apr. 28
American Heroes Air Show

Moody AFB/Valdosta, Oct. 20 & 21
Moody AFB AirFest (Thunderbirds)

Rome, Sept. 14–16
North Georgia Air & Car Show

Vidalia, Apr. 28 & 29
Vidalia Onion Festival Air Show (Blue Angels)

HAWAII

Hickam AFB, Sept. 15
Air Show at Waikiki Beach (Thunderbirds)

Marine Corps Base Hawaii Kaneohe Bay, Oct. 13 & 14
Blues on the Bay (Blue Angels)

IDAHO

Rexburg, June 16
Legacy Flight Museum Air Show

ILLINOIS

Chicago, Aug. 18 & 19
City of Chicago Air & Water Show (Thunderbirds)

Peoria, July 20 & 21
Prairie Air Show

Rockford, June 2 & 3
Rockford AirFest (Blue Angels)

Scott AFB, July 7 & 8
Scott AFB Air Fest

INDIANA

Evansville, July 4
Evansville Fourth of July Air Show (Snowbirds)

Gary, July 14 & 15
Gary Air Show

Indianapolis, Aug. 25 & 26
Indianapolis Air Show (Blue Angels)

Muncie, June 16 & 17
Summer Heat Air Festival

Terre Haute, Sept. 15 & 16
Terre Haute Air Fair

IOWA

Davenport, June 2 & 3
Quad City Air Show (Thunderbirds)

Des Moines, June 30
Fly Iowa – Celebrating 75 Years

Dubuque, July 3
Dubuque Air Show & Fireworks

Sioux City, July 28
Sioux City Air Show

KANSAS

Ft. Scott, Sept. 8
Ft. Scott Air Show

McConnell AFB, July 14 & 15
Air Power in the Air Capital (Blue Angels)

Wichita, Aug. 24–26
Wichita Flight Festival

KENTUCKY

Louisville, Apr. 21
Thunder Over Louisville

LOUISIANA

Barksdale AFB, Apr. 21 & 22
Defenders of Liberty Air Show (Thunderbirds)

NAS JRB New Orleans, Oct. 27 & 28
N'Awlins Air Show (Thunderbirds)

Slidell, Mar. 31
Slidell Open House Air Show

MAINE

NAS Brunswick, Sept. 15 & 16
Great State of Maine Air Show (Blue Angels)

MARYLAND

Andrews AFB, May 19 & 20
DoD Joint Services Open House (Thunderbirds)

MASSACHUSETTS

Otis ANGB, Aug. 25 & 26
Otis ANGB Air Show (Thunderbirds)

Westover ARB, Aug. 11 & 12
The Great New England Air Show

MICHIGAN

Battle Creek, June 29–July 4
Field of Flight & Balloon Festival (Blue Angels)

Bay City, Aug. 11 & 12
Bay City Air Show

Grayling, July 7 & 8
Camp Grayling Air Show

Gwinn, June 23 & 24
Sawyer Experience Air Show

Ionia, July 25
Ionia Air Show

Selfridge ANGB, July 21 & 22
Selfridge ANGB Air Show

Ypsilanti, July 7 & 8
Thunder Over Michigan (Blue Angels)

MINNESOTA

Alexandria, June 23 & 24
Alexandria Air Show

MISSISSIPPI

Greenville, Sept. 8
Delta Air & Balloon Festival

Vicksburg, Oct. 20 & 21
Vicksburg-Tallulah Fly-In & Air Show

SCHEDULE INFORMATION

Provided by the Department of Defense and the International Council of Air Shows (*www.airshows.org*, phone 703-779-8510), as of February 1, 2007. Subject to cancellation or change of date, title, and performers. Check local listings.

AFB	Air Force Base
ANGB	Air National Guard Base
ARB	Air Reserve Base
EAA	Experimental Aircraft Association
JRB	Joint Reserve Base
MCAS	Marine Corps Air Station
NAF	Naval Air Facility
NAS	Naval Air Station
USAF	United States Air Force

MISSOURI

Chesterfield, Sept. 1-3
St. Louis County Fair & Air Show (Blue Angels)

Columbia, May 26 & 27
Salute to Veterans Air Show

Joplin, June 30 & July 1
Joplin AirFest

Kansas City, Aug. 25 & 26
KC Aviation Expo

Mexico, Aug. 18
Elks Military Appreciation Day Air Show

Springfield, July 4
I Love America Air Show

MONTANA

Bozeman, July 28 & 29
Big Sky Air Show (Blue Angels)

Great Falls, May 19 & 20
Malmstrom AFB Air Show (Snowbirds)

NEBRASKA

Offutt AFB, May 5 & 6
Defenders of Freedom Air Show (Blue Angels)

NEVADA

Boulder City, Nov. 3
Boulder City Airport Day

Lake Tahoe, June 23
Minden-Tahoe Air Show

Nellis AFB, Nov. 10 & 11
Aviation Nation (Thunderbirds)

Reno, Sept. 14-16
National Championship Air Races (Snowbirds)

NEW JERSEY

Atlantic City, Aug. 15
Thunder Over the Boardwalk (Thunderbirds)

McGuire AFB, May 12 & 13
McGuire AFB Open House Air Show (Thunderbirds)

Millville, May 26 & 27
Millville Wheels & Wings (Blue Angels)

NEW MEXICO

Holloman AFB, Oct. 27 & 28
Thunder Over the Basin

Tucumcari, Sept. 19
Tucumcari Rotary Club – 60 Years of the Air Force (Snowbirds)

NEW YORK

Binghamton, June 29 & 30
Greater Binghamton Air Show

Geneseo, July 7 & 8
History of Flight and Biplane Rally

Geneseo, July 14 & 15
The Greatest Show on Turf

Niagara Falls, Aug. 11 & 12
Thunder Over Niagara (Thunderbirds)

Wantagh, May 26 & 27
New York Air Show at Jones Beach State Park (Thunderbirds)

NORTH CAROLINA

MCAS Cherry Point, May 5 & 6
MCAS Cherry Point Diamond Anniversary

Pope AFB, Oct. 6 & 7
Pope AFB Open House (Thunderbirds)

Seymour Johnson AFB, May 12
Wings Over Wayne (Blue Angels)

NORTH DAKOTA

Fargo, June 16 & 17
Fargo AirSho (Blue Angels)

Minot, Sept. 8
Northern Neighbors Day (Thunderbirds)

OHIO

Akron, June 30 & July 1
MAPS Air Museum Air Show

Cincinnati, Sept. 22 & 23
Blue Ash Airport Days

Cleveland, Sept. 1-3
Cleveland National Air Show (Thunderbirds)

Columbus, Sept. 28-30
Gathering of Mustangs & Legends (Thunderbirds)

Dayton, July 28 & 29
Vectren Dayton Air Show (Thunderbirds)

Willoughby, Oct. 27 & 28
Gathering of Eagles

OKLAHOMA

Muskogee, Oct. 27 & 28
Air Show Oklahoma (Blue Angels)

Tinker AFB, June 9 & 10
Star Spangled Salute Centennial Air Show (Blue Angels)

OREGON

Hillsboro, Aug. 11 & 12
Oregon International Air Show (Blue Angels)

Madras, Aug. 24 & 25
Central Oregon Air Show

PENNSYLVANIA

Altoona, Aug. 11 & 12
Altoona Air Show

Pittsburgh, June 16 & 17
Wings Over Pittsburgh (Thunderbirds)

Reading, June 1-3
World War II Weekend

West Chester, Oct. 13 & 14
Rotorfest 2007
All Helicopter Show

RHODE ISLAND

North Kingstown, June 23 & 24
Rhode Island National Guard Open House (Blue Angels)

SOUTH CAROLINA

Charleston AFB, Apr. 21 & 22
Charleston AFB Air Expo

Florence, May 26 & 27
May Fly Air Show (Blue Angels)

Ft. Jackson, May 18 & 19
Thunder at Ft. Jackson

MCAS Beaufort, Apr. 21 & 22
MCAS Beaufort Air Show (Blue Angels)

Shaw AFB, Oct. 27
ShawFest

SOUTH DAKOTA

Ellsworth AFB, June 23
USAF 60th Anniversary Bomber Heritage Day

TENNESSEE

Millington, Sept. 22 & 23
MidSouth Air Show (Blue Angels, Snowbirds)

TEXAS

Austin, Apr. 21
American Heroes Air Show

Burnet, Apr. 14
CAF Bluebonnet Air Show

Corpus Christi, Apr. 25 & 26
Buccaneer Days Air Show

Dyess AFB, May 12
Big Country Airpower Day

El Paso, Sept. 22 & 23
Amigo Airsho (Thunderbirds)

Ft. Worth, Oct. 20 & 21
Ft. Worth Alliance Air Show (Blue Angels)

Galveston, Apr. 28 & 29
Lone Star Flight Museum Spirit of Flight

Gilmer, Oct. 21-23
Flight of the Phoenix Airmeet
East Texas Yamboree Festival

Hondo, June 1 & 2
EAA Texas Fly-In

Houston, Oct. 6 & 7
Wings Over Houston (Snowbirds)

Houston, Nov. 3 & 4
World Space Expo Air Show

Midland, Sept. 29 & 30
FINA-CAF Airsho

NAS Corpus Christi, Apr. 14 & 15
South Texas Shootout (Blue Angels)

New Braunfels, Oct. 20
Moonlight Fund Air Show

Randolph AFB, Nov. 4 & 5
Randolph AFB Air Show

San Marcos, Apr. 18-21
65th Doolittle Tokyo Raiders Reunion

Sheppard AFB, Oct. 6
Sheppard AFB Air Show

Waco, Apr. 27 & 28
Texas Aviation Expo

UTAH

Wendover Airfield, Aug. 25
Warbirds Over Wendover

VIRGINIA

Langley AFB, Apr. 28 & 29
AirPower Over Hampton Roads (Thunderbirds)

Richmond, Oct. 20
Chesterfield County Air Show

Virginia Beach, Sept. 8 & 9
NAS Oceana Air Show (Blue Angels)

WASHINGTON

Arlington, July 12-15
Arlington EAA Fly-In

Fairchild AFB, Sept. 22
Skyfest 2007

Seattle, June 16
American Heroes Air Show

Seattle, Aug. 4 & 5
Seafair (Blue Angels)

Tacoma, July 4
Tacoma Freedom Fair Air Show

Tri-City, July 28 & 29
Tri-City Water Follies Air Show

WEST VIRGINIA

Beaver, Aug. 25 & 26
Sound of Freedom Air Show

WISCONSIN

Baraboo, June 30 & July 1
Baraboo-Dells Air Show

Eau Claire, Aug. 18 & 19
Chippewa Valley Air Show

Janesville, Aug. 4 & 5
Southern Wisconsin Airfest

La Crosse, May 19 & 20
Deke Slayton Airfest (Blue Angels)

Manitowoc, June 2 & 3
Thunder on the Lakeshore

Milwaukee, July 14 & 15
Milwaukee Air Expo

Oshkosh, July 23-29
EAA AirVenture

WYOMING

Cheyenne, July 25
Cheyenne ANG Air Show (Thunderbirds)

TYSON RININGER

Guide to the Great

BY JEBBIE GURY

AIRSHOW ACTS YOU MUST SEE.

RICHARD VANDER MUELEN

Pull up your lawn chair for a front row seat at the airshow. Here are eight examples of top acts you'll see this summer. Some are old favorites, some have new airplanes, some you've never seen, but all are outstanding entertainers.

Patty Wagstaff
Cirrus Extra 300S

Patty Wagstaff is famous for getting right down to business, so on takeoff she pops her red and white Extra off the ground into a neck-wrenching roll, then pushes it around into an inverted turn. She keeps up a steady stream of motion from start to finish.

Wagstaff is a three-time U.S. National Aerobatic Champion, a world-level competitor, and the winner of a multitude of awards. When you watch her fly, you see not only the energy that drove her to her championships, but also her sense of fun. Duane Cole, an aerobatic legend, once described her style as "out there killing snakes."

She turns technically precise flying into art and adds complicated details to make the maneuvers more exciting, such as a perfectly level, 360-degree turn with ***snap rolls*** all the way around. Her eight-sided loop with rolls on each line looks like a braided stop sign. "It's fun because it's tricky," she says.

"It's boring to just do a ***half Cuban eight***," says Wagstaff, "so I like to add rolls, so I'm rolling all the time."

Her airplane is similar to a production model Extra 300S, but with a bigger rudder. It has a 350-horsepower Lycoming engine, a 4,000-feet-per-minute rate of climb, and a 420-degree-per-second roll rate.

Aerobatic Dictionary

Snap roll: One wing of the aircraft has stalled – air is no longer passing over it – and the remaining wing, which is still flying, rapidly rotates 360 degrees.

Half Cuban eight: The airplane performs three-quarters of a loop. Once it's upside down and pointed toward the ground, the airplane half-rolls to right-side up. To make a full Cuban eight, it would then repeat the loop and half-roll.

Left to right: Teresa Stokes strikes a pose while Gene Soucy pours on the power. Michael Goulian descends in his new Extra 300SHP, while Patty Wagstaff takes her Extra 300 for a spin. Check our 2007 schedule (p. 48) for airshows where you can see these performers.

ERIK HILDEBRANDT (2)

Aerobatic Dictionary

Shark's tooth turn: The airplane climbs vertically, then pulls over backward to fly a downward line at a 45-degree angle. It's like a Cuban eight, but the lines are all straight instead of curved.

Knife-edge pass: Knife-edge flight means the aircraft is rolled into a vertical bank, with the airplane either topside or underside to the audience.

Red Baron Pizza Squadron, 2007

Bryan Regan (lead), Jayson Wilson (left wing), Matt Losacker (right wing), and Travis Aukes (slot)

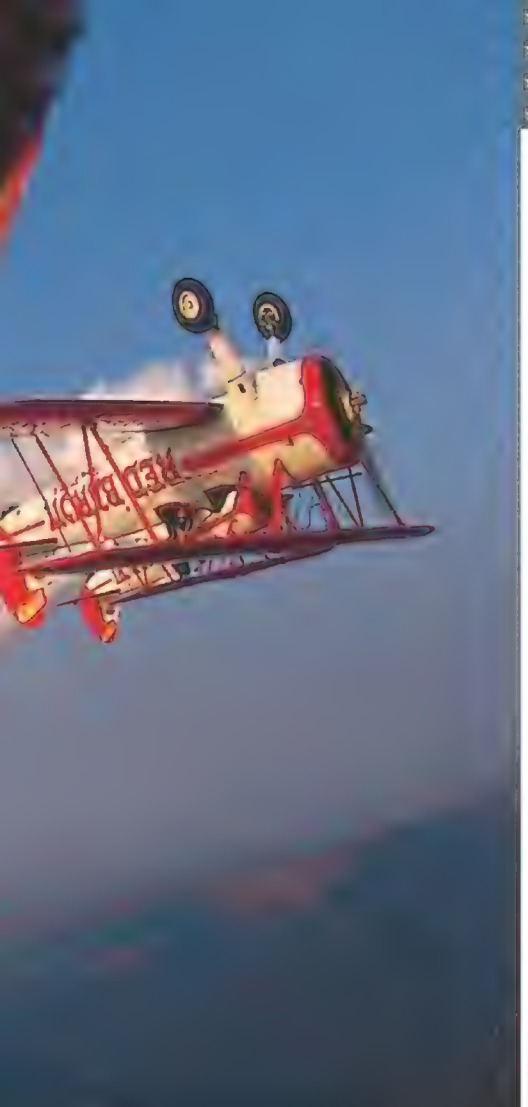
With the Red Baron Pizza Squadron, there's the grandeur of four red and white Stearmans looping across the airfield, and then there's the noise – a quartet of radials, 1800-hp worth of Pratt & Whitney growls, that build to a crescendo as the airplanes loop closer and closer in their formations, then erupt into more agile pairs.

The aerobatic flow is constant. One set overlaps the other, filling the air with Cuban eights, vertical rolls, ***shark's tooth turns***, and opposing ***knife-edge passes***. A few of their wonderful maneuvers are the diamond cluster ***hammerhead*** with all the airplanes climbing, floating, and pivoting together; the Staggerhead, with them pivoting in trail; and two big hearts.

One airplane climbs at a 45-degree angle, trailing smoke, for the left side of the heart, from the bottom up. The other climbs first, turns on his smoke, then loops around the right side from the top down to complete the heart.

The planes are 450-hp Stearmans, built in the early 1940s and later streamlined for airshow flying.

John Bowman leads the Red Barons head over tail. Opposite, below: Kent Pietsch lands on an RV runway.



ERIK HILDEBRANDT

Kent Pietsch
Jelly Belly Jelly Beans Interstate Cadet

Watching Kent Pietsch the first time can be pretty scary. First, you think he's going to crash into another airplane (even though the pilots have rehearsed), because he comes out of nowhere and busts into someone else's aerobatic routine, surprising everyone. Then after the first airplane gets out of the way, you think Pietsch's Interstate Cadet is going to crash anyway because it pulls straight up, slides back on its tail, drops an aileron (the ailerons enable an airplane to roll), and starts spinning. Even when you know it's a comedy act, watching one thing after another fall off or out of the airplane makes you hold your breath until he's back on the ground.

Pietsch flies a few more acts after the comedy. One is the Dead Stick routine. At 6,000 feet above the runway, he stops the engine, lights his wingtip smokers, and begins a 10-turn spin until he's down low. All the while, he's careful not to go too fast so the propeller won't start turning again as he rolls, hammerheads, and ***split S***'s with the engine off for seven minutes. The announcer joins in the act, standing out on a taxiway with his hand out in front of him. Pietsch finishes by rolling the unpowered airplane all the way up to touch the propeller spinner to the announcer's hand.

For another trick, he lands his Jelly Belly Jelly Beans-sponsored Interstate Cadet on the top of an RV truck, with only eight inches of clearance on either side of the tires. The air currents around the RV can be a problem. If he gets too low at the back, the RV blocks his airflow and the airplane won't fly. At the front of the RV, downdrafts will suck him toward the runway, so after he does land on the roof and rides a little way there with his wheels in a groove, he has to lift the airplane off smartly with full power and a firm pull on the stick.

When Teresa Stokes wingwalks, gravity is her best friend.

RICHARD VANDER MUELEN

Gene Soucy and Teresa Stokes
The Showcat

Only the wind holds Teresa Stokes to the airplane on takeoff. She stands on the lower right wing and waves at the crowd as Gene Soucy flies the Showcat. He climbs, turns, and even does a barrel roll with her standing out there.

When he climbs to 300 feet, she scrambles over the cockpit and onto a post at the center of the top wing where she buckles herself in for a wild ride. "That's the fun part," she says, "when I'm just having a ball, laughing and screaming and looking around."

When Soucy gets down low again, Stokes unbuckles her belt and does wingwalking poses like the Head Stand and the Hand Shake. When she's done, she has to hustle to get back in her seat before Soucy lands – he likes to see how quickly he can get back on the ground in front of the crowd.

Soucy flies two other acts in the Showcat: a classic biplane solo and a night show with fireworks. The Showcat is a Grumman Ag Cat cropduster he had converted to a wingwalker's airplane. It was never designed for any of the wildly exotic maneuvers, but it is big, beautiful, and fun to watch.

For his night show Soucy wires the plane with so many fireworks that he can't look out at the wings after he lights them or they'll make him night blind. They leave a trail of fire a couple of hundred yards long.

RICHARD VANDER MUELEN

Aerobatic Dictionary

Hammerhead: The airplane climbs vertically until the airspeed is zero, then pivots back toward the ground in a vertical dive.

Split S: The airplane rolls to inverted, then the pilot points its nose down and flies a half-loop until the airplane is pointed in the other direction, right-side up.

Sean D. Tucker
Oracle Challenger

The flaming red biplane is a mile high when Sean D. Tucker kicks it into 14 dizzying snap rolls, its smoke trails carving tight spirals in a blue sky, the prop tips screaming. "I do that for the noise," he says. "The snap is over-speeding and the tips are going 'whop, whop,' so people look up, and even if they've never seen me fly before, they say, 'This guy means business!' "

Then he dives to 275 mph and goes into his Centrifuge, where he is head over heels, tail over nose on a 45-degree arc, eight, nine, 10 times. After these extreme moves, he climbs a short way and talks to the audience over the radio. Winded from the effort of the aerobatics, he also sounds exhilarated. "I want to put people in my cockpit and give them a flying lesson and technically walk them through what I experience as I tumble through the sky," he says.

Tucker's airplane, which began life as a Pitts Special, is a combination of old and new. Its fuselage has a traditional tubular steel frame, but its wings are state-of-the-art, squared off, and powered by a total of eight ailerons to allow it to roll 500 degrees per second. The tail surfaces are so revolutionary that the airplane can mimic a 3-D radio-controlled model that stops, hovers, spins, and twirls in place.

At some shows Tucker also leads a four-plane formation act with his son Eric, Jim Freelove, and Bill Stein.

COURTESY ORACLE

Sean D. Tucker's high-G maneuvers in his Oracle Challenger II (above) are dizzying crowd-pleasers. Right: Tucker with enthusiastic fans.

FIND OUT MORE

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MORE GREAT AIRSHOW ACTS and insights from professional aviation photographers can be found on our Web site.

ARNOLD GREENWELL

Michael Goulian is pumped up on his taxi out to perform at AirVenture 2005 in Oshkosh, Wisconsin.

Chuck Aaron
Red Bull Helicopter

There are other so-called aerobatic helicopter acts out there, but nothing like the Messerschmitt-Boelkow-Blohm Bo-105. In the hands of the right pilot, it loops, rolls, does vertical rolls, and flips.

Unlike other helicopters, this one is built with a rigid rotor and rigid mounted main transmission, both of which are bolted onto the airframe so that the machine handles like a sports car, without slop or slack in the controls. When Chuck Aaron moves the control stick to the left, the Red Bull Bo-105 rolls all the way around, without the rotor tilting or bending.

Aaron is fairly new to the airshow circuit. This will be the second season he flies aerobatic shows in the Red Bull Helicopter, but he has more than 17,000 hours of helicopter flight time. He has done flight testing with infrared night-vision equipment, cropdusting, flight instructing, film flying, aerial photography, heavy sling work, cattle herding, traffic reporting, banner towing – nearly any job a helicopter pilot can do.

Michael Goulian
Castrol Extra 300SHP

Over the microphone we hear Michael Goulian say, "Okay, we're ready to start," then there's a countdown, Five, four, three, two, one, and he begins a diagonal line of rolls. His Castrol Extra 300SHP keeps coming down, from 3,200 feet high and 80 mph at the beginning to 260 mph, just above the runway. Then he goes vertical for a long straight, precise rolling climb.

Goulian began competition aerobatics not long after he learned to fly. Within 10 years of his first flying lesson, he competed at the national and international levels, winning many awards, including the title of U.S. National Aerobatic Champion. Now he has a full-time airshow schedule, but he says, "If you say that you're a championship pilot, you need to fly like a championship pilot. I've tried to make sure that everything I do stays precise on a competition level."

About 50 to 60 percent of his choreography is a combination of classic aerobatics with some kind of gyroscopic tumbling in the middle of it, so that it goes from a beautiful competition maneuver into something that looks out of control, but that stops precisely on some axis, whether it be inverted, upright, or vertical. "So, if I'm going to do a triple flip," he says, "I make sure I do it three times and that when I'm done, it's stationary, looking at the audience, every time."

Goulian's airplane was specially built for him, and he worked with Walter Extra to decrease its weight and increase its instability with a new tail design. Under the cowling, he has Lycoming's first Thunderbolt IO-580, a new high-performance engine that has 347 horsepower.

Aerobatic Dictionary

Gyroscopic maneuver: In this maneuver, the airplane appears to be out of control and completely unstable as it tumbles tail over nose, or cartwheels wing over wing and spins like a gyroscope.

COURTESY REDBULL-PHOTOFILES.COM

OPPOSITE: TYSON RININGER

Chuck Aaron does the improbable in his Red Bull helicopter.

LEFT: ERIK HILDEBRANDT; ABOVE: TYSON RININGER

At night, Steve Oliver streams sparklers from a Super Chipmunk (top). Suzanne Asbury-Oliver has the day job: using smoke to write billboards in the sky (above).

Steve Oliver and Suzanne Asbury-Oliver

Oregon Aero Sky Dancer

If traffic stops so people can read the signs in the sky on Thursday, Friday, and Saturday before the airshow, it probably means Steve Oliver and Suzanne Asbury-Oliver are in town. They use their Super Chipmunk, also known as the Oregon Aero Sky Writer, Sky Dancer, and Fire Dancer to sky write, fly aerobatics, and do a pyrotechnic night show, respectively.

Skywriting, the Olivers will tell you, is a lost art, shrouded in the mystery and romance of the 1930s, when pilots would lie rather than divulge the secrets of how they made thick, lasting smoke, how they formed precise, evenly matched letters, and how they chose altitudes where the words hung in the air most legibly. Suzanne promises to pass on the secrets before she retires, the way her mentor did 30 years ago.

Steve flies the aerobatic acts in the Super Chipmunk, which was built as a basic Canadian military trainer in the 1950s. The team shortened its wings, re-skinned them with metal, enlarged the control surfaces, and super-sized the engine to 385 horsepower to get more performance out of it, but the craft still has the charm of the era in which it flew.

Steve makes the most of that look by turning his airshow into a toe-tapping 1950s Sock Hop. His pre-recorded narration begins with a guitar riff, then the voiceover says, "Come on, Steve, let's rock and roll." Bill Haley and the Comets respond in song with "One, two, three o'clock, four o'clock rock," and the Chipmunk pulls up into its first vertical dance move. The upbeat music includes crowd favorites like Elvis and Chubby Checker.

At night, Steve's airplane becomes the Fire Dancer, looping and twirling thousand-foot streams of fireworks off its wingtips, while a Bob Seger soundtrack thrums in the background.

Brian Grote is a flight instructor with 20 years aviation experience. He also writes monthly columns on subjects pertaining to aviation.

FLYBY

ARTICLE WRITTEN BY: BRIAN GROTE

Dear Brian,

I've been flying for over 20 years. My usual run is a Denver departure at 9pm, fly to Billings, on to Cheyenne and then back to Denver by 5am. I fly a King Air 350. I love my career and I pride myself on doing the best job I possibly can.

Last time out, however, I was making lots of little mistakes. I was cleared for the ILS Runway 35R into Denver, but I couldn't pick up ATIS. That's when I looked at my radios and noticed I had dialed in the wrong frequency. I glanced again and dialed in the right frequency. I continued though my checklist and set my Radar Altimeter to 5500 feet. I was ready to make my descent and start my approach. After the outer marker I glanced at my DH again and noticed that I had set my Radar Altimeter, 67 feet low. Luckily, I landed safely, bouncing the wheels just a little.

After a couple more days in the sky I could tell my eyesight was beginning to deteriorate. I knew I wouldn't be able to renew my first class medical if I didn't do anything about it. I was really worried and started asking my peers if there was anything I could do. A co-worker gave me a bottle of Claroxan™ and told me it would help me maintain my depth perception. I was skeptical at first, but tried it anyway. As it turns out, the stuff works great. The problem is, I ran out and don't know where to find more. Have you heard of this Claroxan™ stuff? Is it available in the States?

Jason, 46 – Seattle, WA

Jason,

Not only do I know of Claroxan™, it just so happens I take it everyday. Being a pilot myself, I know that perfect visual acuity is an asset none of us can afford to lose. That's why every pilot should be protecting their eyesight before it's too late.

Claroxan™ contains ingredients proven beneficial for the eyes. Among these ingredients are lutein and zeaxanthin – powerful antioxidants that have been clinically proven to protect the retina and macula and, in some cases, reverse the damaging effects of macular degeneration. These antioxidants block damaging UV rays and halt damaging free radical oxidation in the back of the eyes. They have also been clinically proven to decrease the risk of cataracts.

Claroxan™ also contains bilberry, an anti-oxidant known to improve night vision. Bilberry's night vision enhancing effects were first noticed in England in the early 1940's. The RAF ordered English fighter pilots to eat bilberry jam on toast figuring it would give them an advantage during night raid missions against the German Luftwaffe fighters.

Claroxan's unique proprietary formulation is completely safe, all-natural and extremely affordable. As far as ordering it, you can call them toll-free at 866.775.3937, or go to "www.claroxan.com/AAS". I usually get mine within a week after ordering.

Hope this helps!
Brian

THE himalayan CATARACT project

The Himalayan Cataract Project strives to eradicate preventable and curable blindness in the Himalaya through high-quality ophthalmic care, education, and establishment of a sustainable eye care infrastructure.

Based in Asia, at Kathmandu in Nepal, the Project is empowering local physicians to alleviate the suffering caused by blindness through unique programs including skills-transfer education, cost-recovery, research, and the creation of a world-class network of eye care facilities.

In 2004 and 2005, 3% of PacificHealth profits were donated to HCP for development and construction of eye facilities in the Himalaya.

Visit CureBlindness.org to learn more about HCP.

CLAROXAN™ | LEADER IN VISION IMPROVEMENT

Sunlight, aging, and diet each cause damage to the retina and macula, which can lead to a decline in vision that glasses or contacts can't help. If you've experienced an increase in blurriness or difficulty seeing details at any range, then you know how valuable sharp vision can be. What you might not know is that in the past three years, a flood of new scientific research has been done on natural vision enhancement. This medical research suggests that ingredients in Claroxan™ may help maintain and even improve your vision, while at the same time giving you added protection against many ocular diseases

Claroxan™ may improve macular pigment density, which research shows has amazing effects on vision. By improving macular pigment density, ingredients in Claroxan™ may improve normal visual acuity, contrast sensitivity, and even glare reduction. Participants in one clinical study reported that ingredients in Claroxan™ improved their long range vision outdoors – in some cases, they were able to distinguish far away ridges up to 27 miles further than normal! Even if you have perfect vision now, Claroxan™ may help give you an edge by improving your visual reflexes and may allow you to pick up on moving objects faster than ever before.

People who count on their vision – people like pilots, hunters, military, and even pro athletes – trust Claroxan™ as the best source available for vision enhancement and protection. Claroxan™ is safe, effective, and extremely affordable. However, people with serious health concerns should consult a doctor before use.

That Extra

Has aviation finally caught up with Willard Custer?

BY TIM WRIGHT

IF BOB ENGLAR IS CORRECT, he may be well positioned to breathe new life into an airplane design long abandoned as dead. "Good aero ideas recycle," says the engineer from his laboratory at the Georgia Institute of Technology Research Institute in Atlanta.

Englar is applying decades of his own research to an aeronautical oddity that hasn't always been recognized as a good idea: the Custer Channel Wing. The channel wing, which takes its name from the semicircular trough each wing forms below the engine, is a 1940s design that didn't get past a prototype. But the channels, which seem out of place, if not freakish, in an airplane's wing, generate high levels of lift, and that opens up all sorts of design possibilities.

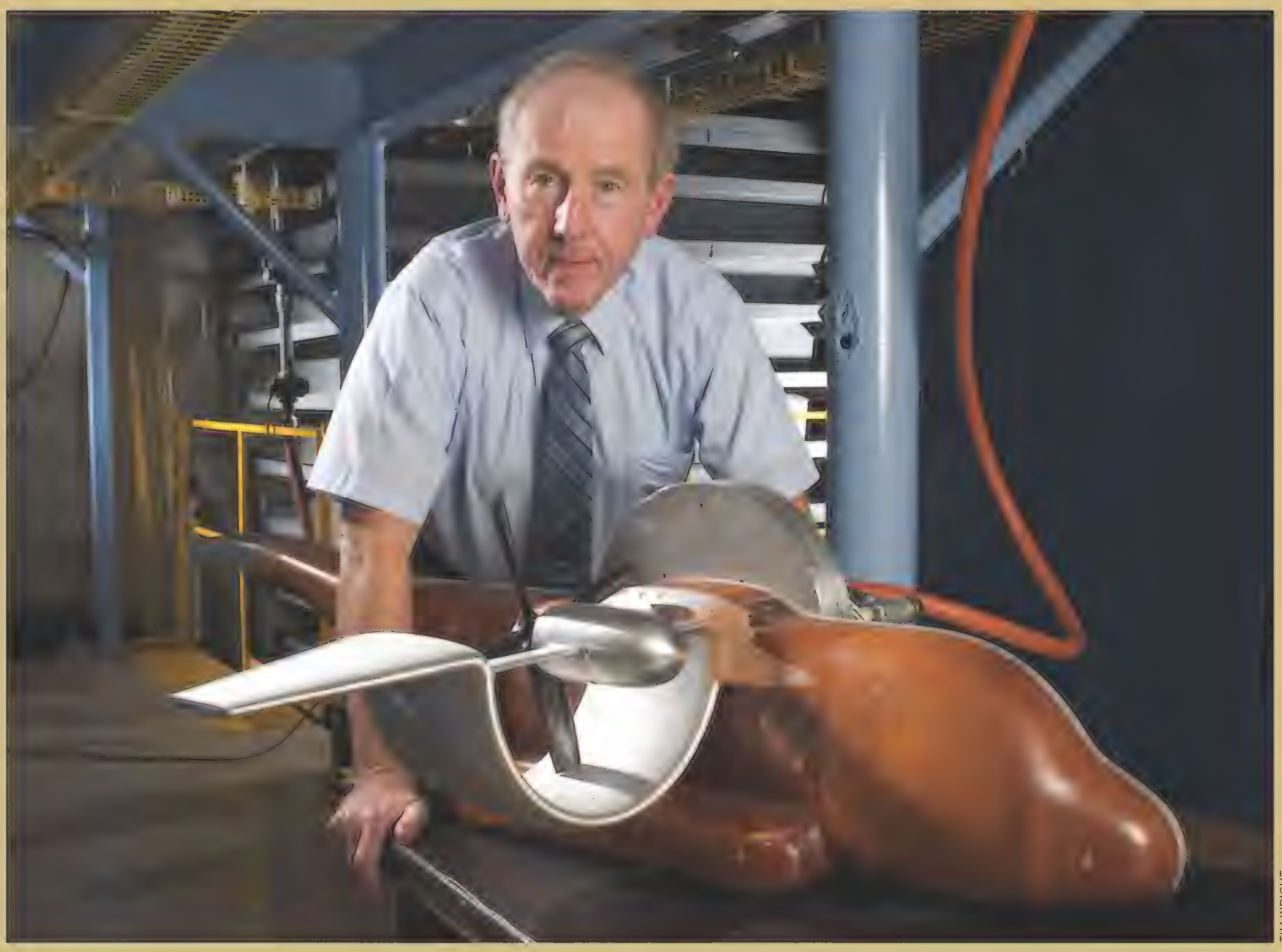
NASM (SI NEG. #2000-1186)

Englar is combining the concept with other techniques to generate the extreme lift needed to raise a C-130-size transport off a 60-foot runway, or keep a futuristic personal air vehicle hovering above a suburban driveway. NASA funded his studies from a small program investigating novel ways to make aircraft more efficient.

Building deep channels into the wings of aircraft, dropping like twin smiles under the propellers, was the idea of Maryland inventor Willard Custer. Custer's insight was that the amount of lift generated can depend on the speed of air over the wing, not, as had been thought, solely the speed of the wing moving through the air.

"The beauty of the Custer Channel Wing is that we can generate lift at zero forward speed by using the engines to provide airflow," says Dennis Bushnell of NASA's Langley Research Center in Virginia, who is the primary force behind the research. "What you need is *relative* motion."

Little Lift



TIM WRIGHT

Bob Englar revived the Custer Channel Wing for wind tunnel experiments directing airflow. Opposite: Willard Custer's CCW-2 flies in 1948, during one of several successful demonstrations ultimately ignored by industry and government.

In addition, the shape of the channel deflects propeller thrust downward, as much as 26 degrees. With this extra lift, an aircraft with a channel wing is quickly airborne once it begins rolling and is able to maintain control at very slow speeds. Custer envisioned airplanes that could take off or land almost vertically, making him an early prophet of short-takeoff-and-landing aircraft.

The trouble with being a prophet is that people don't always listen. In 1943, Custer's first aircraft, the CCW-1, demonstrated STOL ability to the U.S. Army with a flight in Maryland. Despite interest by the media and some aircraft manufacturers, the CCW-1 was ultimately deemed impractical because it couldn't maintain

Willard Custer in 1948, building his trademark channel wing spars at a no-frills laboratory in Hagerstown, Maryland. Not one of his designs was used on production airplanes.

control if it were to lose one engine and because it required an extreme nose-up attitude to land safely.

In 1959, Custer tested CCW-5 for the Marine Corps, and despite the aircraft's unique aerodynamic performances, it too was rebuffed. Part of the reason for these failures was that Custer was unable to adequately explain to the military the advantages his channel wing seemed to bestow.

To land Custer's airplanes required flying at high angles of attack, a dangerous attitude because the pilot can't see over the nose of an airplane. Also, the failure of one of the two engines at a high angle of attack could lead to dangerous rolls or stalls.

FIND OUT MORE
www.airspacemag.com
HOW A MUSEUM volunteer who had met Willard Custer was able to identify mysterious photos of a channel wing model that surfaced at NASM.

But science may have caught up with the inventor. In 1995, Bushnell became the new research chief of the Langley center. Among the bundles of correspondence he inherited from his predecessor was a letter setting forth "technical quibbles" related to the testing of the Custer Channel Wing done in Langley's 30- by 60- foot wind tunnel in 1950s. Inspired by the letter, Bushnell "went to school" on the design, and grew impressed by the potential.

Years later, while driving home from his office, Bushnell was mulling over the growing demand for ways to get aircraft in tight spaces off the ground. The accepted methods, rotary wing and direct thrust, weren't enough. Then it hit him. If combined with "circulation control," a method of generating lift by using jets of air to improve the aerodynamic efficiency of wings the forgotten design could provide another option. "The channel wing couldn't do it, circulation control couldn't do it, but maybe they'd be able to do it together," Bushnell says.

Bushnell directed some money from his discretionary funds, reserved for high-risk, high-payoff projects, and "got back into it" with a program that lasted from 1999 to 2004. The grant money funded Englar's laboratory work at Georgia Tech. Since then, Bushnell and Englar have co-patented their marriage of circulation control and the channel wing, and Englar continues his work under the auspices of Georgia Tech.

TIM WRIGHT

CCW-5 at its home at the Mid-Atlantic Aviation Museum in Reading, Pennsylvania, awaiting a rehabilitated reputation.

Circulation con-

NASM (SI NEG. #00032785)

trol is based on the Coanda Effect, named for Romanian aviation researcher Henri Coanda, who in 1910 found that hot gas exiting a jet followed the contour of plates he had installed to deflect the exhaust. Coanda had inadvertently discovered the tendency of a pressurized gas to adhere to an adjacent curved surface. That tendency can be used to increase the lift created by an airplane wing if the exhaust is deflected downward by the wing's trailing edge.

Circulation control technology works by blowing compressed air—rather than Coanda's exhaust—over curved trailing or leading edges to achieve very high lift, where and when needed. Researchers believe that circulation control can one day make moving surfaces on aircraft obsolete. By replacing flaps and other mechanical lift maximizers with pneumatic air hoses, engineers can make airplanes lighter, quieter, and easier to maintain.

To find the ideal way to combine circulation control with Custer's design, Englar used the modern methods of computational fluid dynamics, including data from wind tunnel tests of sensor-studded models. One early goal was to prove that a channel wing with enhanced circulation control could turn a generic twin-engine transport into a super-STOL machine.

The wind tunnel model has an electronic motor that drives either two or three propellers. These can be positioned at various locations to test which placement generates the most lift. In a typical test from 2002, for example, various levels of prop thrust and blowing pressure were tested while the model was kept at a constant angle of attack. In other tests, the angle was changed while the other conditions remained constant.

The research confirmed the potential aerodynamic payoffs of the design in ways that Custer simply could not have. Says Bushnell, "You couldn't have computed it back then."

Custer understood that the airflow to generate lift could come either from the airplane's forward motion or from the engine. But the former auto mechanic and salesman didn't know—and given the technology of the time, couldn't have known, engineers now say—that his channel wing caused the air flowing over it to separate and become turbulent. At low speeds and smaller angles of attack, the flow of air detaches from the surface it is traveling across, leading to a loss of the pressure difference that causes lift. Custer could not determine when this would happen, or how to design around it. Also, he didn't have the digital design tools that could have shown him how to place the external struts of his aircraft without interfering with its aerodynamics.

Englar's task is to find a way to simultaneously use the channel wing's ability to generate a lot of lift while weeding out the problems associated with the design. To land, Custer's airplanes had to be flown at high angles of attack, a dangerous attitude because the pilot can't see over the nose of an airplane. Also, at a high angle of attack, the failure of one of the two engines could lead to dangerous rolls or stalls, with no way to compensate.

"We were trying to avoid all those problems" by using circulation control, Englar says. The blowing air increases the already considerable lift, eliminating the need to land at those high angles of attack. The pneumatic controls enable pilots to quickly compensate for engine failure or other dangerous asymmetries.

Like Custer, Englar fervently believes in his work despite the disappointment that his circulation control systems have not been adapted for production aircraft or for other vehicles beyond prototypes.

Englar shares some of the same frustration Custer felt when he was trying to convince the world to do something new. Use the word "curse" in relation to this grim similarity and Englar won't object. "It takes a while for people to realize the potential," he says. "And when they believe you, they say, 'Well then why is it not being used in any production airplanes?' "

Circulation control, however, continues to attract attention. Engineers in Britain are designing an unmanned aircraft that would be controlled only by directed airflow and thrust vectoring, and the Navy is investigating the use of circulation control on Navy submarines, which could use water jets instead of dive planes and rudders. Englar's extensive wind tunnel tests have also proven that circulation control can reduce drag on tractor-trailer rigs, improve traction on race cars, and help control high-speed race boats.

Circulation control technology works by blowing compressed air over curved trailing or leading edges to achieve very high lift. Researchers believe it can one day make moving surfaces on aircraft obsolete. By replacing flaps and other mechanical lift maximizers, engineers can make airplanes lighter and quieter.

Meanwhile, Custer's CCW-1 awaits restoration at the Smithsonian Institution's National Air and Space Museum, and the CCW-5 sits forlornly on the tarmac at the Mid-Atlantic Aviation Museum in Reading, Pennsylvania. They have remained mere curiosities, but thanks to Englar, Bushnell, and renewed interest in short-takeoff-and-landing designs, the channel wing design may one day be transformed from a museum piece to a real, live flying airplane.

Fields of

The New Mexico Spaceport Authority expects to open its 18,000-acre site in 2010.

AN EPIDEMIC IS CREEPING ACROSS the face of the Earth, one that has nothing to do with bird flu, West Nile, or any other microbe in the news, but rather with a disorder that appears to affect the judgment of those afflicted and magnify their ambitions. It's a uniquely 21st century technological manifestation known as...The Spaceport. Infected with enthusiasm for the new businesses promising to launch masses of humanity into space—Richard Branson's Virgin Galactic, for example, has signed up as many as 1,000 passengers for an up-and-back trip—people have suggested building spaceports in places like Upham, New Mexico; Burns Flat, Oklahoma; Van Horn, Texas; Sheboygan, Wisconsin; Columbus, Ohio; and in Singapore, Sweden, Nova Scotia, and Australia.

The forces behind spaceport fever include national, state, and local governments, crown princes, private investors, dot-com billionaires, regular billionaires, aerospace engineers, test pilots, former astronauts, rocket hobbyists, and space cadets of every stripe. All seem to believe that spaceports will be the hot new industry, the next biotech, a completely novel sector of commerce that will produce tall geysers of cold cash and bring jobs, rocket paparazzi, and throngs of deep-pocketed tourists, spectators, and assorted space-niks swarming into the spaceport's neighborhood. In a scrubby patch of southern New Mexico, for example, a spaceport—Spaceport America—is poised to bring economic salvation to a state that ranks 39th in gross state product.

"Potentially it's 6,000 jobs," said New Mexico governor (and now presidential candidate) Bill Richardson last year. "The potential for tourism, for jobs, for new technologies moving into New Mexico is huge."

It was Richardson himself who was responsible for bringing Virgin Galactic to the state as Spaceport America's anchor tenant—a feat akin to getting Microsoft to move to Santa Fe, perhaps, except for the minor detail that Virgin Galactic had, at that point, no operational spacecraft in the stable and wouldn't for some time.

Jerry Larson, president of UP (pronounced *up*!) Aerospace, another Spaceport America tenant, is also bullish on the spaceport's future. "There's this huge market waiting there," Larson told the *Rocky Mountain News* last September. "It's a multi-billion-dollar industry waiting to be birthed."

Admittedly, in the case of New Mexico's spaceport, a few skeptics were lurking in the wings, people whose somewhat more jaundiced visions were not of spaceports but of space pork. In 2005, the New Mexico legislature appropriated $100 million of the estimated $225 million required for spaceport construction, but state senator John Grubesic wasn't having any of it. "This is your classic Old West story of your snake-oil salesman who comes to the dying town promising to revitalize it," he said in the *San Francisco Chronicle*. "Unfortunately, people have bought it, hook, line, and sinker."

(The "dying town" in this case could well be Truth or Consequences [*née* Hot Springs], about 30 miles west of the spaceport, population 7,289. That this gritty little village, composed mainly of gas stations, Mexican restaurants, saloons, Mexican restaurants, laundromats, and Mexican restaurants, could use some major revitalization was beyond doubt.)

But for all the P.T. Barnum hucksterism around it, it's not as if the spaceport-to-riches scenario were built on nothing but dreams. On October 4, 2004, Burt Rutan's *SpaceShipOne* won the $10 million Ansari X Prize, thereby demonstrating that private companies could launch humans into space. The week before the winning flight, Rutan and Richard Branson announced a

Dreams

by Ed Regis

DAVID SIMMONS

Space tourists have to be launched from somewhere. Ten states and half a dozen foreign countries think they have just the spot.

deal whereby Rutan would license the *SpaceShipOne* technology to Branson for a new company, Virgin Galactic, that would take paying passengers on flights into space—to an altitude of 60 miles. A spate of other companies immediately announced similar plans but without proven technology to back them up (see "Go Ballistic!" Feb./Mar. 2006).

What did back them up was a market study, issued in October 2002 by the Futron Corporation, a consulting firm located in Bethesda, Maryland. In a 50-page report entitled "Space Tourism Market Study: Suborbital Space Travel," the company claimed to be providing an objective assessment of an unknown and unproven market. Futron had commissioned Zogby International, a polling firm, to survey 450 well-off individuals in an effort to gauge their willingness to pay handsome fees for a space experience. The survey considered factors such as income levels, vacation and leisure spending, physical fitness, perception of the riskiness of traveling into space, willingness to undergo a week of training and to experience zero-G flight, and so on. Zogby asked whether the chief appeal of a spaceflight was the view of Earth from space, the acceleration of a rocket launch, or something else. The company even fine-tuned the results by adjusting for those whose desire to fly into space was tied up with being a pioneer, one of the first to go.

The Futron study's conclusion was that by 2021, some 15,700 passengers would be flying into suborbital space per year, generating total annual revenues of $786 million. A separate study of orbital flight demand concluded that in the same time period, up to 60 passengers would be spending $300 million per year, for total revenues of almost $1.1 billion annually. That was not quite the "multibillion-dollar industry" spaceport boosters had forecast, but still, it was big money.

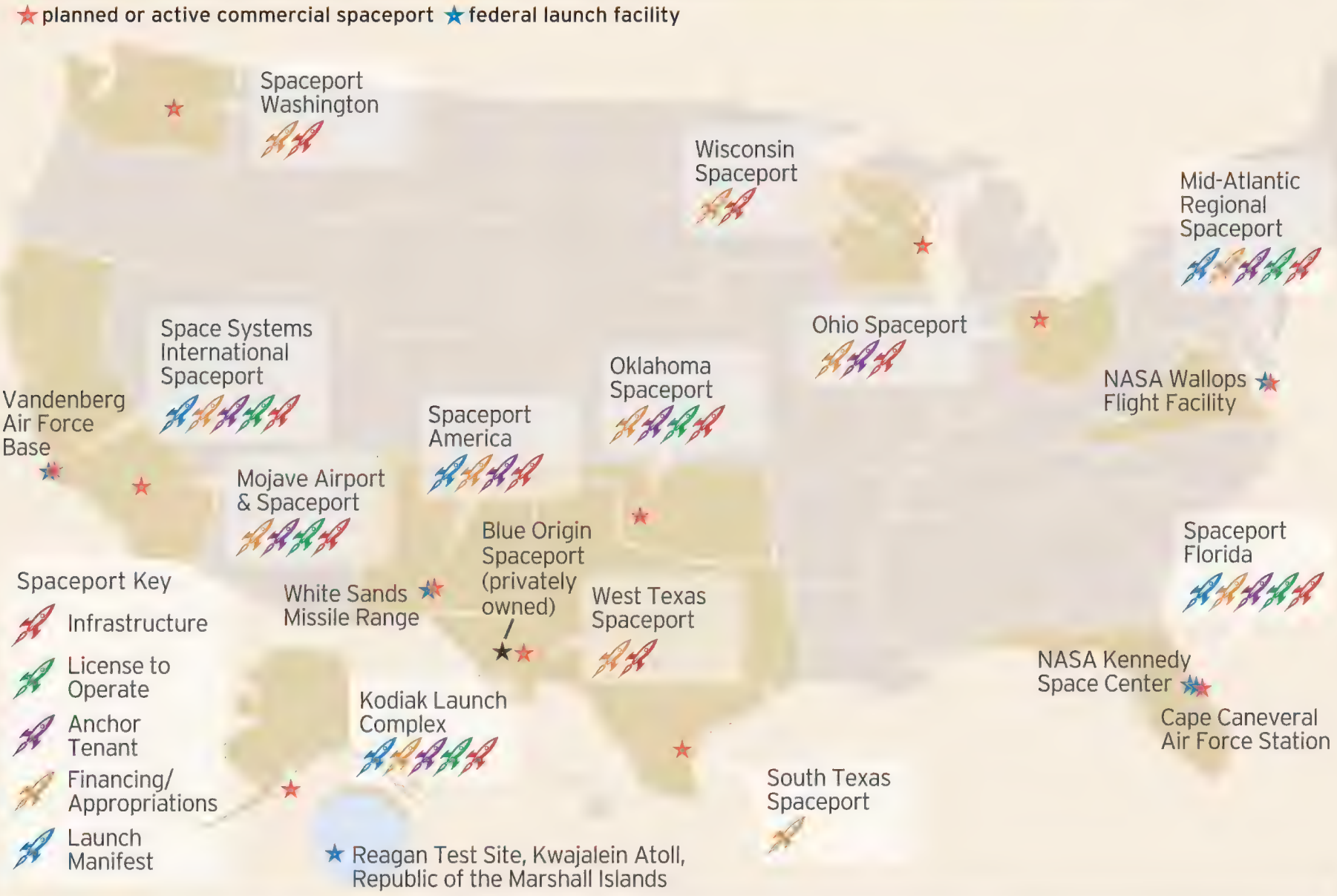
But then last August 2006, Futron issued another report: "Suborbital Space Tourism Demand Revisited." The new study's conclusion was slightly sobering: Despite the fact that *SpaceShipOne* had won the X Prize in the interim, the projected demand for such flights had actually declined. The annual passenger load predicted by 2021 had fallen from the original estimate of 15,700 to 13,000, while anticipated revenues fell from $786 million to $676 million. The price of a suborbital spaceflight, by contrast, had risen from the original figure of $100,000 to $200,000, which happened to be exactly the sum that Virgin Galactic was then quoting for a flight aboard *SpaceShipTwo*.

Futron theorized that the weakening of projected demand was due to two main factors. One was the doubling of ticket prices; the other was something that had plagued space ventures from the very beginning: delays. The original 2002 study had assumed that commercial suborbital flight would begin in 2006. But 2006 had come and had almost gone, and not a single manned commercial flight had been made, nor had any of the required space vehicles rolled out of the factory.

In the end, there was no getting around the fact that even though they were based on polls and were the product of intelligent analysis, all of these prophecies fell into the realm of sheer theory. What an interviewee will say in a telephone call and what the same person would actually do when faced with the real thing are two entirely separate matters. The people involved were not spending any folding money or putting their lives on the line; they were merely taking part in a survey.

The glib auguries of a "multibillon-dollar industry," therefore, were pretty much wishful thinking based on guesswork, a phenomenon otherwise known as hype. Sooner or later the reality of the situation will have to be faced.

U.S. Commercial Spaceports and Federal Launch Facilities



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IF WE DEFINE A SPACEPORT as a site dedicated to launching rockets that can carry tourists into space for private profit, the blunt fact is: There are no spaceports. There are military and federal rocket-launch complexes that have been converted or expanded for commercial uses (see "Payloads Other Than People," p. 67). There is the Kodiak Launch Complex in Alaska, which has the dual distinction of being the first licensed launch site not co-located with a federal facility and the first U.S. launch site built since the 1960s. But as for spaceports—as defined, there are no such animals in the jungle.

The Oklahoma Spaceport, for example, is a former U.S. Air Force facility (the Clinton-Sherman Air Force Base) that during the 1950s was home to Strategic Air Command B-52s. Today the field consists of a 13,500-foot runway, a couple of abandoned-looking buildings, a control tower, and the most crucial item of all, an on-site golf course. (Didn't Al Shepard hit a golf ball on the moon?) Rocketplane, the Oklahoma City commercial spaceflight firm, was to be the anchor tenant. But last June, when the Oklahoma Space Industry Development Authority requested a $2 million appropriation for infrastructure upgrades, the state legislature refused. ("We're considering what to do about that," said a Rocketplane spokesperson last October.)

Spaceport Washington is an ember from the previous wildfire of space optimism, ignited in 1996 by VentureStar, a proposed Lockheed Martin launch vehicle that was to dramatically lower the cost of getting stuff into orbit. The wedge-shaped, single-stage VentureStar was to launch vertically from Edwards Air Force Base in California and land horizontally, space shuttle-like, on a very long runway. Washington's Grant County International Airport with its 13,452-foot runway was one of several western sites that fit the bill.

The cancellation of the VentureStar program in 2001 did not dampen the state's zeal nor that of Aero-Space Port International, a real estate development group, for opening a spaceport in Washington. ASPI corporate counsel Kim Foster says, "Because of our legacy with the Boeing company, Washington state is proactive when it comes to space." Despite the airport's wide-open spaces (a feature it shares with many proposed spaceports), no company has indicated enough interest to get the state to apply for a Federal Aviation Administration license to operate a launch site.

One potential spaceport operator who has applied to the FAA is *Amazon.com* founder Jeff Bezos. His company Blue Origin launched a rocket (which reached a height of 255 feet) from a site in west Texas last November, but there's no spaceport there yet.

Even the Mojave Spaceport (a.k.a. the Mojave Airport and Civilian Aerospace Test Center), notwithstanding its having been the site of the only successful manned private spaceflights

Proposed International Spaceports and Anchor Tenants

CANADA: Sydney Mines, Cape Breton, Nova Scotia, PlanetSpace

SWEDEN: Esrange Space Center, Kiruna, Virgin Galactic

AUSTRALIA: Woomera, Adelaide, RocketPlane

UNITED ARAB EMIRATES: Ras Al-Khaimah International Airport, Space Adventures

SINGAPORE: Changi Airport, Space Adventures

in history, and having been licensed in 2004 by the FAA as a spaceport, always had been, and thereafter continued to function as, an airport, identified as MHV in official FAA publications, Notices to Airmen, airport directories, instrument approach and departure plates, navigational charts, and so on.

The fabled spaceports of Dubai, Singapore, and elsewhere exist primarily in the form of Web sites and/or misty artist's conceptions.

Against all this, the only launch site that has remotely approximated the concept of an operational spaceport for private, as opposed to government, launch vehicles and payloads was a tiny patch of concrete in the New Mexico desert across the San Andres Mountains from the White Sands Missile Range command center. Here, at Spaceport America, on September 25, 2006, UP Aerospace (UPA), a private rocket company based in Connecticut, attempted its first commercial launch.

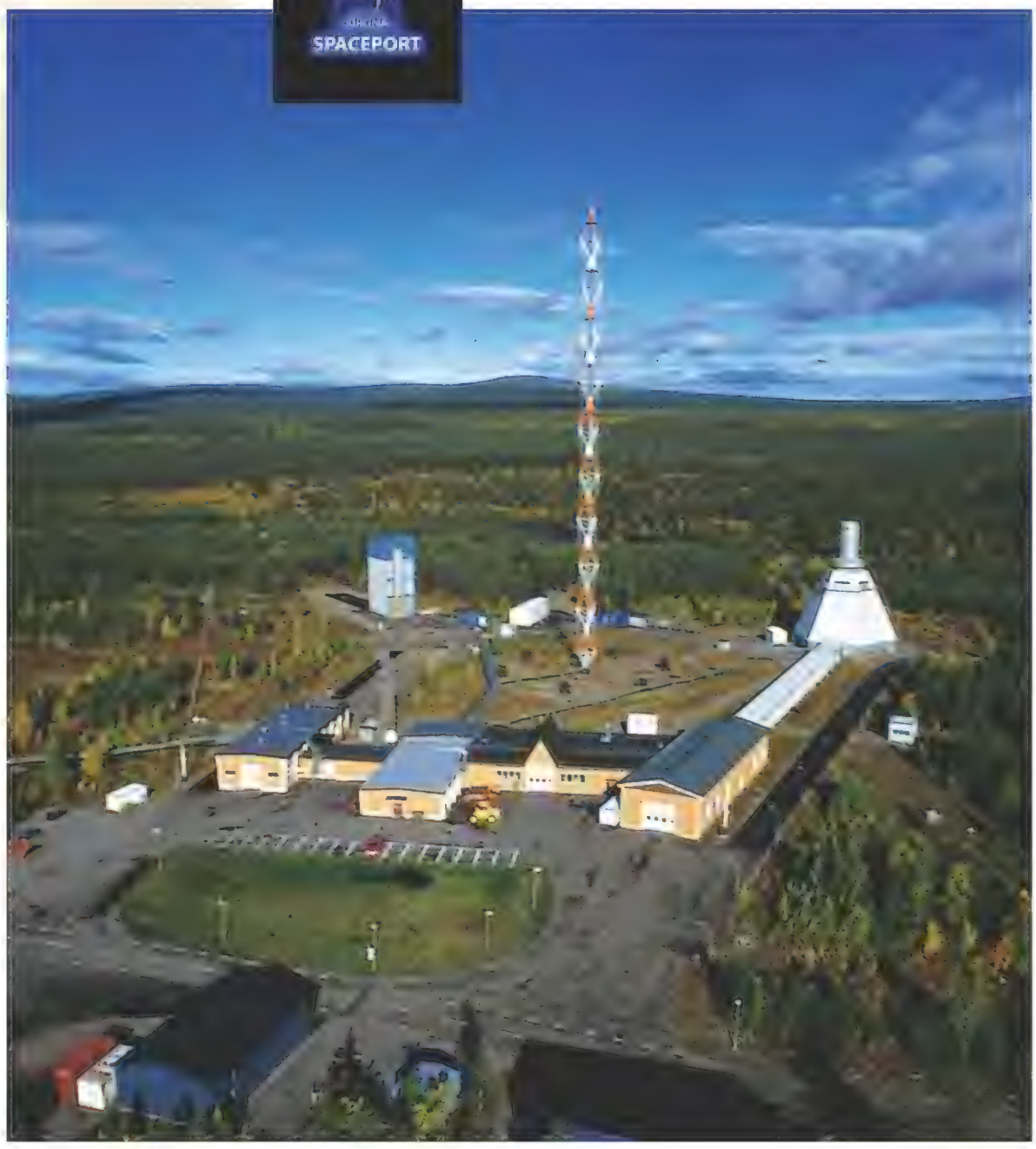
Because Spaceport America does not yet have its spaceport license, UP Aerospace obtained FAA approval to launch from temporary facilities.

The story began the night before, at the "Mission Safety Briefing" held at the Hilton Las Cruces, which, even though it was some 100 miles from the launch site, was serving as UPA mission headquarters. The mood was giddy. Not once at the safety briefing was the word "safety" mentioned. Mostly, the event gave UPA the opportunity to introduce its launch crew and allowed the company's college, high school, and elementary school clients to describe their science payloads. Colleges in New Mexico, Connecticut, and Colorado were flying experiment packages, such as a three-axis accelerometer, a magnetometer, and a Geiger counter, among other things. Two fifth-grade students, Alison and Lydia from Farnsworth Aerospace Elementary School in St. Paul, Minnesota, had placed three wristwatches—two analog and one digital—aboard to find out which type would better survive microgravity, reentry, landing, and the 13 Gs of liftoff. In all, there were about 40 payloads inside the SpaceLoft XL-1 rocket, a 20-foot-long, 10-inch-wide craft that would be shot into the blue the following day.

Next morning, members of the media, UPA clients, and guests left the hotel at about 3:30 a.m. for the 100-mile drive to the VIP

JUAN THOMASSIE

After 40 years of sounding rockets, Sweden's Esrange facility is welcoming space tourism company Virgin Galactic.



SPACEPORT SWEDEN (2)

Spaceport Singapore, envisioned by Space Adventures, Ltd., would cost $115 million. A Singapore-based consortium and the Crown Prince of Ras Al-Khaimah in the United Arab Emirates are backing the venture.

viewing area, which was about three miles from the launch site. The site itself consisted of little more than a concrete launch pad, the launcher rail (called "T Rex"), and a couple of modular structures functioning as the vehicle's final assembly building and the launch control center.

Arriving at the viewing area in temperatures just above freezing, launch-goers could see faint traces of dawn behind the San Andres range to the east. Launch time was set for 7:30 a.m. Well before then, Rick Homans, New Mexico's state secretary for economic development who was acting as master of ceremonies, announced over the PA system that the rocket's transponder wasn't working. The transponder was essential for recovering the payload: The vehicle had no guidance system; the rocket, aimed a few degrees from vertical, would be launched ballistically, like a cannonball. The plan was for the rocket to reach Mach 5 in 13 seconds, then coast to its target altitude of 70 miles. At that point, the nosecone would separate from the body of the rocket, parachutes would deploy, and both sections would come down gently within a 20-mile-wide area somewhere in the White Sands Missile Range, which would track the thing by radar. The entire flight was to take approximately 13 minutes. However, fixing the transponder required the removal and replacement of 72 bolts.

Hours later the transponder is working. During the delay, UPA's commercial clients take the chance to describe their payloads. A Las Cruces company, Heavenly Journeys, is flying the ashes of a veterinarian whose widow is attending the launch. Another firm is flying ingredients for an energy drink. There are other oddments—a plastic bag of 12 Cheerios, for one—all tucked away inside pizza-shaped payload containers.

As the final countdown nears, launch time shifts back and forth from 2:05 to 2:15 with no explanation. Reuters is here, ABC, Fox News, National Public Radio, Associated Press, a French film crew, local reporters—there's probably more media here than customers—millions of cameras on tripods to record the flight that is to inaugurate the revolutionary, paradigm-shifting, historic era of public access to space.

At last the rocket gets away. Watching it is a thrilling experience: a point of dazzling white light followed by a contrail straight as a knife edge and as bright as if it were illuminated from the inside. Then, suddenly, the contrail becomes a corkscrew, and I'm immediately reminded of the *Challenger* disaster. In a few more seconds, although everybody is still looking skyward at the twisting track of rocket exhaust, it's announced over the PA system that, barely three minutes into the flight, the rocket is back on the ground.

Back on the ground?

AN ASSOCIATED PRESS STORY filed five days later described the SpaceLoft XL rocket as "the first launched from a commercial spaceport in New Mexico—and the first to crash." That was not in the least surprising. At the post-flight briefing, held the same night back at the Hilton, Lonnie Sumpter, executive director of the New Mexico Spaceport Authority, who had also acted as the flight's launch director, said: "Forty-six percent of first launches suffer a failure."

Sumpter, who died in February after a brief illness, was a com-

manding presence. A mechanical engineer who had spent 16 years at White Sands flight testing missile systems, he knew whereof he spoke. Still, a 46 percent failure rate was scarcely a comforting thought in view of the question on some people's minds, namely: What if this had been a manned flight?

The crash of the UPA rocket was a cautionary tale. It is wrong to think that rocket flight is like aircraft flight, only a little higher and a little faster. Unlike atmospheric aircraft, a spacefaring rocket undergoes extremes of acceleration and deceleration, plus vibration and buffeting, reentry heat, and other space-specific influences. All these factors combine to make spaceflight a classic case of "sensitive dependence upon initial conditions," meaning that the smallest mechanical, software, or other imperfection—such as the brittle O-ring that doomed *Challenger*—can have momentous outcomes.

Such a defect was catastrophic to UPA's SpaceLoft XL-1 and to most of its scientific payloads. The University of Colorado's electronics package had been reduced to a charred, deformed, and melted husk. Central Connecticut State University's package, broken into pieces, had returned no data. Alison and Lydia's analog watches, despite having been carefully encased in bubble wrap, had stopped at 2:17. The digital watch was defunct, its face blank.

In January 2007, the company announced that the crash had been caused by a defective tailfin assembly, which engineers have since redesigned. And there was a silver lining: Worldwide coverage of the first launch had produced so much publicity that UPA's next two flights were fully booked.

UP Aerospace will not make or break the New Mexico spaceport; Virgin Galactic will do that. But in the aftermath of the UPA crash, some of the major players in space tourism were taking a second look at how the crash (or a series of crashes) of a manned private rocket, plus a raft of huge liability claims, would affect the industry. Last October, some of the high priests of space tourism met in Las Cruces for the International Symposium for Personal Spaceflight. *NewScientist.com*, which covered the meeting, reported a few of their comments:

"Space is risky, and safety will be one of the defining factors in the development of space tourism for the first few years," said Eric Anderson, president and CEO of Space Adventures, the Arlington, Virginia firm that has arranged five visits to the International Space Station for wealthy clients, including the latest, Charles Simonyi, the creator of Microsoft Word.

"No matter how much energy we put into safety, there is a chance of an accident," said Alex Tai, chief operating officer of Virgin Galactic.

"What happens if someone in the industry crashes and burns? It could affect everyone," said Kirby Ikin, of Asia Pacific Aerospace Consultants.

Even Apollo 11's Buzz Aldrin, the second man on the moon, said that he would decline the offer of a private rocket flight. "I don't need that publicity anymore and I don't need that risk."

And who could blame him? Accidents have eliminated not only individual aircraft types—such as the de Havilland Comet, three of which broke up in the air between May 1953 and April 1954—but entire modes of transportation. The *Hindenberg* disaster of 1937 ended travel by Zeppelin, and the crash of the Concorde in 2000 effectively terminated journeys by supersonic transport. The up-and-down flight planned by Virgin Galactic—a voyage from nowhere to nowhere and back again—does not even have the advantage of being a mode of transportation: It is, merely, entertainment. That may be the saving grace.

In the end, whether spaceports will be a bubble or a business will be determined by the reliability of the spacecraft involved and by the space tourists' ability to tolerate risk. Plenty of people engage in dangerous sports such as mountain climbing, untethered rock climbing, and BASE jumping, an extreme hobby in which a person jumps from a Building, Antenna, Span (such as a bridge), or point of Earth (such as a cliff), and opens a parachute on the way down. BASE jumping has had its share of fatalities (the latest occurred last October, when an experienced BASE jumper died moments after leaping from New River Gorge Bridge in West Virginia), but the sport, and the deaths, continue. Maybe the same will hold true of private manned rocket flights.

So are spaceports the wave of the future, the next big growth industry? The only safe, sane, and sensible answer is: Nobody knows. As physicist Niels Bohr used to say: "Prediction is very difficult, especially about the future."

OPPOSITE: SPACE ADVENTURES

Payloads Other Than People

Federal policies are becoming more supportive of commercial space endeavors. In June 2005, for example, NASA Administrator Mike Griffin announced the agency would consider private companies for missions to supply the International Space Station. In this business-is-good-for-space climate, several commercial spaceports are operating side by side with government launch complexes, taking advantage of a national policy to rent federal infrastructure to private users, as long as they don't interfere with government business. The Mid-Atlantic Regional Spaceport (with the evocative acronym MARS), for example, is located on what old space hands know as Wallops Island, which since 1945 has staged more than 14,000 launches, mostly of sounding rockets.

"We are a tenant at a federal facility," says spaceport manager Rick Baldwin. "We have created our own infrastructure. We created the orbital capability at the range."

Baldwin used that capability last December when an Air Force Minotaur I rocket placed an Air Force satellite and a few piggybacking NASA payloads in orbit from his launch pad. His next-door neighbor, NASA's Wallops Flight Facility, provided tracking and range safety.

"That's what the federal policy says we should be doing," says NASA's Jim Ball, the spaceport development manager at the Kennedy Space Center in Florida. "How do we broaden the use of our facilities by non-NASA users?" Ball is finding customers for the Shuttle Landing Facility at Kennedy—at 15,000 feet, one of the world's longest runways.

Both Ball and Baldwin have talked to space tourism companies, but most private spaceports near federal sites are catering to the tried-and-true clients – NASA and the Pentagon – who want to launch satellites, not sightseers.

LINDA SHINER

Riding it was a test that separated the men from their equilibrium.

by Mark Wolverton

THE G MACHINE

JOHN GLENN called it a "dreaded" and "sadistic" part of astronaut training. Apollo 11's Michael Collins called it "diabolical." *Time* magazine referred to it as "a monstrous apparatus," a "gruesome merry-go-round," and, less originally, a "torture chamber."

The Johnsville human centrifuge—the machine everyone loved to hate—was operated by the Navy at its Naval Air Development Center (later the Naval Air Warfare Center) in Warminster, Pennsylvania, just outside Philadelphia. For almost 50 years—it ceased government operation in 1996—the centrifuge was the world's most powerful and versatile tool for studying the G forces that are an inescapable part of flight.

In his 2006 book *Getting off the Planet: Training Astronauts*, Randall Chambers notes, "Very early in the space program, amusement park rides were considered as possible research vehicles to study acceleration forces." But Chambers, the scientist who trained all the early astronauts, soon realized that such machines wouldn't take the extreme forces and sustained abuse needed to conduct serious studies on humans. A high-performance centrifuge, a machine that could produce high acceleration and thus high G-forces by rapid rotation, was the only solution.

By July 1950, inside a giant round 11,000-square-foot building at its Johnsville facility, the Navy had completed the world's largest centrifuge, which consisted of a 10- by six-foot oblate sphere steel ball, or gondola, at the end of a 50-foot arm. (The oblate sphere gondola was later replaced with a 10-foot-diameter sphere.) A 4,000-horsepower electric engine at the other end whipped the arm around a huge chamber. The dual-gimballed gondola, mounted to the arm on rotating bearings, allowed the test subject to be oriented in various positions relative to the applied G force. This enabled the centrifuge to be used as a "dynamic flight simulator," capable of accurately reproducing the sensations experienced by pilots in various flight maneuvers. Researchers reveled in the opportunity to study G forces under controlled conditions at levels previously accessible only in high-performance aircraft. Simply by turning the gondola as it spun about the arm, experimenters could subject pilots to positive Gs ("eyeballs in," with acceleration in a head-to-foot direction), negative ("eyeballs out," foot-to-head, similar to a rapidly descending elevator), transverse (chest to back), and practically every other variation that might be experienced during flight.

NASA

NASA HISTORY OFFICE

Astronaut Scott Carpenter grimaces as the Johnsville centrifuge piles on positive G-forces.

The Johnsville centrifuge rose to stardom at the beginning of America's space program. It started operating with the training of pilots for the North American X-15 hypersonic aircraft and hit its stride with the Mercury manned spaceflight program.

COURTESY DOUG CROMPTON

To test human responses to G forces, the Navy put subjects in a 10- by six-foot oblate steel sphere (above) at the end of a 50-foot arm (left).

"We were really worried about what was going to happen when we started spaceflight," says Barry Shender, a biomedical engineer and specialist in acceleration stress who worked at Johnsville. The centrifuge's flight simulation capabilities made it possible to reproduce all the ways various spaceflight scenarios could affect astronaut performance. "We did the early Mercury training of John Glenn and [Wally] Schirra and all the rest of those guys just to learn what happens if we go up to these sorts of accelerations in these different vectors," Shender says. "We were talking about reentry and during takeoff, long-term exposures. So if we're going to develop these ballistic profiles, how much can people take? It was a great unknown."

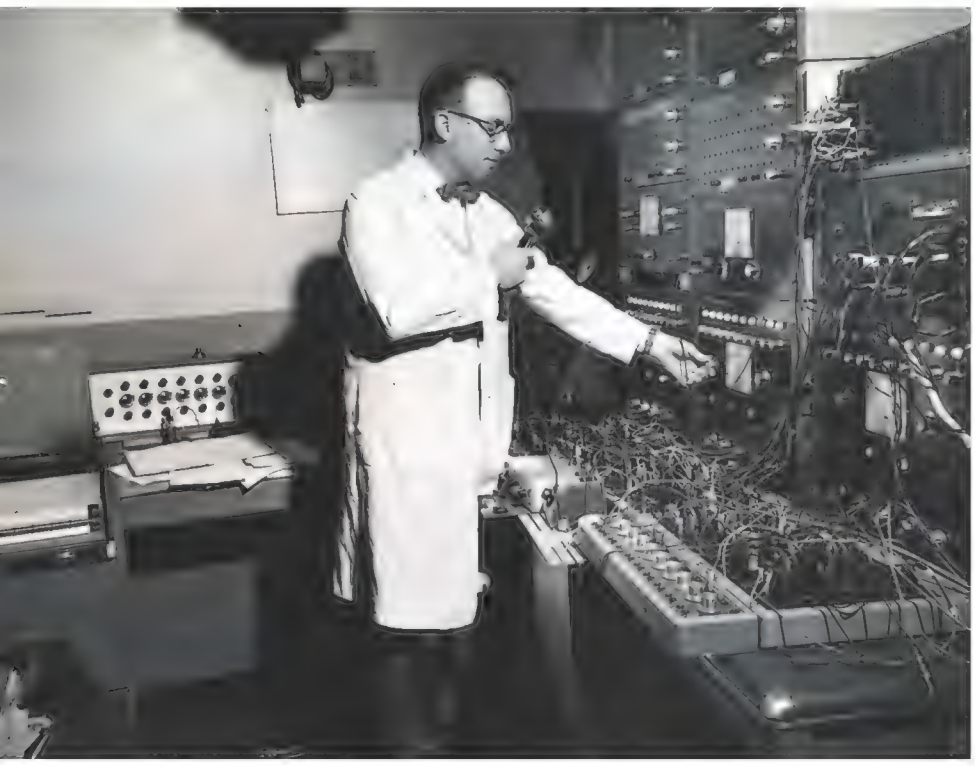
For the Mercury, Gemini, and Apollo astronauts, the "wheel" was both a rite of passage and an invaluable training tool. "Whirling around at the end of that long arm, I was acting as a guinea pig for what a human being might encounter being launched into space or reentering the atmosphere," Glenn recalled in *John Glenn: A Memoir*. "You were straining every muscle of your body to the maximum...if you even thought of easing up, your vision would narrow like a set of blinders and you'd start to black out."

One objective of such ordeals was to teach an astronaut to counteract the G demons by using breathing techniques and muscle contractions. Michael Collins recalls in his 1974 autobiography *Carrying the Fire*: "If you breathe normally, you find you can exhale just fine, but when you try to inhale, it's impossible to reinflate your lungs, just as if steel bands were tightly encircling your chest. So you have to develop an entirely new method, keeping the lungs almost fully inflated at all times, and giving rapid little pants 'off the top.'"

Some people not only tolerated the centrifuge, but strove to test its limits—and their own. "Things were different in the '50s and '60s," Shender says. "You could wake up in the morning and think, *Let's do something crazy today*, and then do it."

In August 1958 Navy Reserve officer Carter C. Collins rode the wheel to more than 20 Gs for a record 54 seconds. Later that day, R. Flanagan Gray, a civilian psychologist, repeated the feat. A year later, Gray would go on to greater fame as the first man to ride the "Iron Maiden," a project that began with a rather odd idea about counteracting G forces.

"I think it started when somebody spun a fish and didn't notice anything irregular about the fish because of the high Gs," says Stephen Cloak, a Navy research en-



COURTESY RICHARD CROSBIE

Richard Crosbie, longtime manager of the Johnsville centrifuge, operates the rat's-nest of wires that made up the first computer-based control unit.

gineer and veteran centrifuge jockey. "So they postulated that if we put a human encased in water, it would dissipate the G forces and they could take high G." The Maiden was an aluminum capsule designed by Gray, sculpted roughly in the shape of a seated human, that could be filled with water. Gray stayed alert throughout the 25-second run up to 32 Gs, suffering only mild sinus pain. "He was another one of these late '50s, early '60s guys that just kind of kicked the tires and went at it," says Cloak. Gray wanted to go to the full 40-G capability of the centrifuge, but the Maiden was too big to fit inside the gondola and so had to be mounted farther inward along the arm, where 32 Gs was the maximum acceleration possible.

In the late 1950s, two scientists, Carl Clark and James Hardy, had a more daring idea. Physics dictated that if a spacecraft could be steadily accelerated at 2 Gs, it could reach the moon or Mars in days or even hours. But could a human being survive the constant acceleration? Clark used the centrifuge to find out.

"He essentially moved into the cab, brought his La-Z-Boy from home, and stayed in there at 2 G for 24 hours," says Shender. Clark slept, ate, worked, and lived at two Gs for a full day under constant medical surveillance. He suffered nothing more than fatigue. Further marathon rides were planned, but more immediate space missions loomed and the idea was set aside.

One factor that eventually discouraged the sportier research projects was the mounting evidence of all that could happen to the body under acceleration. Under high Gs, Cloak explains, "you're insulting the brain with a lack of oxygen in the blood. Each person's brain is a little different, so you don't know what's going to happen." Aside from G-LOC (for "G loss of consciousness"), possible effects included motion sickness, disorientation, anxiety, euphoria, and confusion. Cloak adds, "You get swelling of the feet and ankles, ruptured blood vessels in the groin area, blood clots, temporary change in blood-flow patterns in the lungs, possible collapsing of the lungs, fractured ribs, chest pain. For your heart it's entirely possible to have arrhythmias, transient electrical changes, myocardial infarctions, interesting little things like that."

Most of these effects were transient and fairly rare, but they were not to be dismissed. "We had to go through a battery of exams," Cloak recalls, "because one of the major risks is sudden death. No matter how well they screen you, you just don't know when you get in there if a 9-G ischemic insult to your system is gonna kill you or not." Then there are the mild phenomena, such as petechial hemorrhaging. "You actually look like you've got measles—at high Gs, blood leaks through the blood vessels and you get little pinpoints all over. It's kind of interesting, especially the first time you see it."

Cloak rode the centrifuge routinely throughout his career at Warminster as an acceleration researcher. "I used to tell everybody it broke the week up," he says

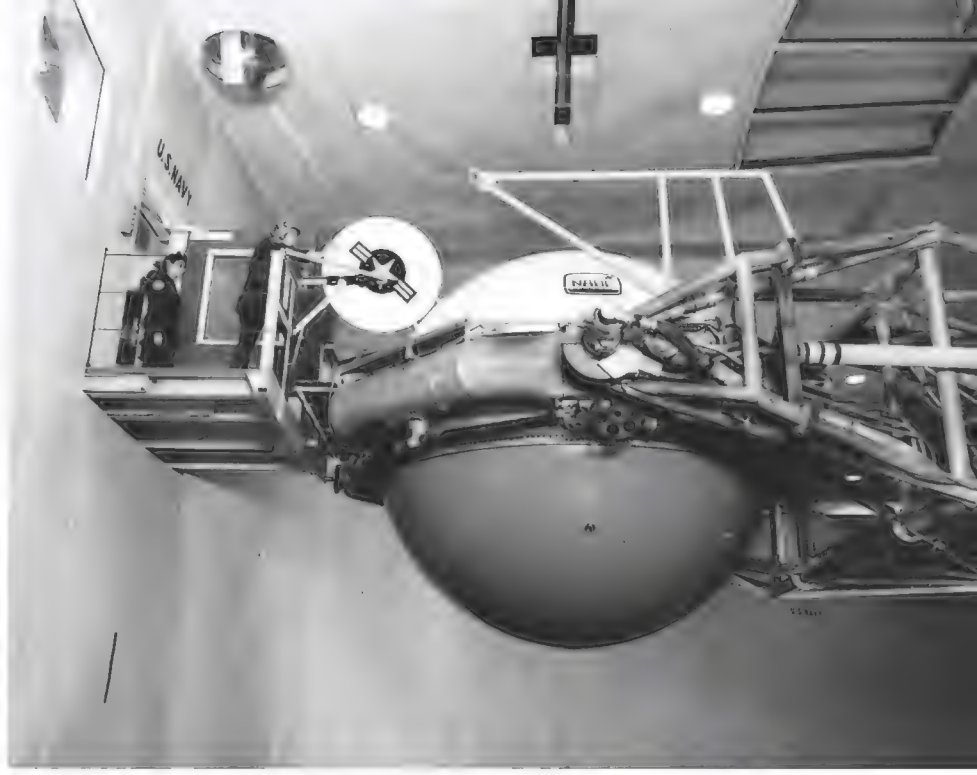
NASA HISTORY OFFICE

Left: Supine in the gondola, astronaut Deke Slayton checks the instrument panel before startup, while a researcher eyes the contraption from a ceiling-mounted station. Opposite: Astronaut Frank Borman similarly preps for a spin.

with a laugh. He adapted quickly: "135 rides later, it was just like getting up and walking around. You get so used to it." He became such an expert rider that he ended up teaching anti-G techniques to Navy fighter pilots.

Not everyone was a "G monster" like Cloak. For Barry Shender, one go-round was enough, a routine familiarization ride that didn't exceed a mild 3 Gs. "I'm not the roller-coaster-ride type," he admits. Centrifuge engineer Bill Daymon was another one-timer, although in his case the purpose of the ride wasn't familiarization but basic troubleshooting. "People were hearing noises, and I took a 3-G ride to listen to it," he recalls. "That was my only ride. The year before I had had bypass surgery, and they were rather reluctant to let me ride it again."

Subjects generally rode the centrifuge in one of two modes: closed-loop, or dynamic flight simulation, in which the rider had full control over the movements of the centrifuge; and open-loop, or "meat in a seat," in which the rider was essentially a lab rat at the mercy of the researchers. Riders were usually given various tasks to perform under the G stresses, such as flying simulated combat missions and other activities demanding certain cognitive or motor skills. Doctors monitored all test subjects at every moment, and both the subject and the doctors had the capability to immediately stop the ride. It's a testament to the Johnsville researchers that no one was ever seriously injured riding the centrifuge.



COURTESY DOUG CROMPTON

This 10-foot sphere replaced the original gondola in 1958. The centrifuge educated aerospace scientists for nearly 50 years before being shut down in the 1990s.

Despite the discomfort and dangers, willing volunteers were never in short supply. "You have to give a lot of credit to the folks that volunteer to do it," Shender says, "because basically we beat them up every day, and they come back." So why did they clamber into the belly of the beast? "Motivations like *I want to see what I can do physically. I want to do something that would make good stories. I want to do something that'll get me out of the office today.*" Subjects could also score a souvenir. "If they like, we give them a video of their experiences in the centrifuge so they can show their family and friends when they lose consciousness and how silly they looked."

The centrifuge research has had a lasting impact on the training of military pilots, the development of anti-G suits and techniques, and the design of aircraft and spacecraft systems. Aside from the biomedical effects of high Gs, the Johnsville researchers investigated practical problems, including the disorientation of Navy pilots following night catapult launches from a carrier, and spin recovery techniques in fighter aircraft such as the F-4B Phantom and F-14 Tomcat. Such projects used the centrifuge's flight simulation capabilities to full effect. Sometimes the centrifuge was used to re-create the conditions of puzzling crashes that might indicate aircraft design flaws.

The last decade of operations at Johnsville saw one of the centrifuge's most important contributions. "Back in the '90s there was a mandate from Congress that everybody should be able to go into the tactical cockpit, boys and girls, small people, big people," says Shender. "We developed what we called the Gender Neutral Study, where we wanted to ask the question: What happens if you're a small female and you get put into one of these high-performance jets? Can you fly? Can you eject? Can you hold your head up?" As it turned out, women can more than hold their own against the flyboys. "We established that they can certainly fly high-G maneuvers without any difficulty, and certainly [have] comparable acceleration tolerance with the men," says Shender. "These female subjects had a good time doing it. And they didn't complain nearly as much as the male subjects do."

In 1996 the Warminster base fell victim to the Base Realignment and Closure Act, and the Naval Air Warfare Center moved to the Navy's Patuxent River facility in Maryland, leaving the centrifuge behind. Veridian Corporation, a private contractor, kept it spinning for mostly Navy programs for a while, but by 1999 mounting costs forced the wheel into retirement. Although centrifuge work continues at other military and NASA centers, "we're sort of gearing down," Shender says regretfully. The center of the action appears to be shifting overseas, with new centrifuges in Sweden and Japan. None measures up to Johnsville in capabilities or sheer engineering chutzpah.

As for the Johnsville centrifuge, proposals for its future use range from the sedate, such as turning the facility into a museum, to the outlandish, such as turning it into a thrill ride—an unlikely scenario, given that the deaths of two riders on Epcot Center's "Mission: Space" simulator were linked to G-induced stresses. Shender and Cloak continue their work in acceleration science at the Naval Air Warfare Center at Patuxent River, while veterans of the center like Bill Daymon meet at reunions to trade war stories. Regardless of whether the Johnsville centrifuge ever spins again, its legacy in aerospace history—and in the memories of all who rode it—is secure.

NASA HISTORY OFFICE

Sightings

PICTURES WORTH A SECOND LOOK

THE PREFERRED PLATFORM for air-to-air photography is an open tail-gunner's position on a B-25. It's an expensive and hair-raising ride, but one that gets viewers enticingly close to airplanes in their natural environments.

Phil Makanna, famous for his photographs of restored World War II airplanes, demonstrates his commitment to his craft with a view of his high-flying sneakers (left) framing the B-26 Marauder below. His photo of a P-51D Mustang and a T-33 Shooting Star trainer (below) streaking through the clouds shows that the extra effort is worth it.

The daring exhibited by these professionals can be imagined from the runway pose of Paul Bowen (opposite, bottom), who shot the dramatic image of a Cessna Citation X (opposite, top) from a similar perch.

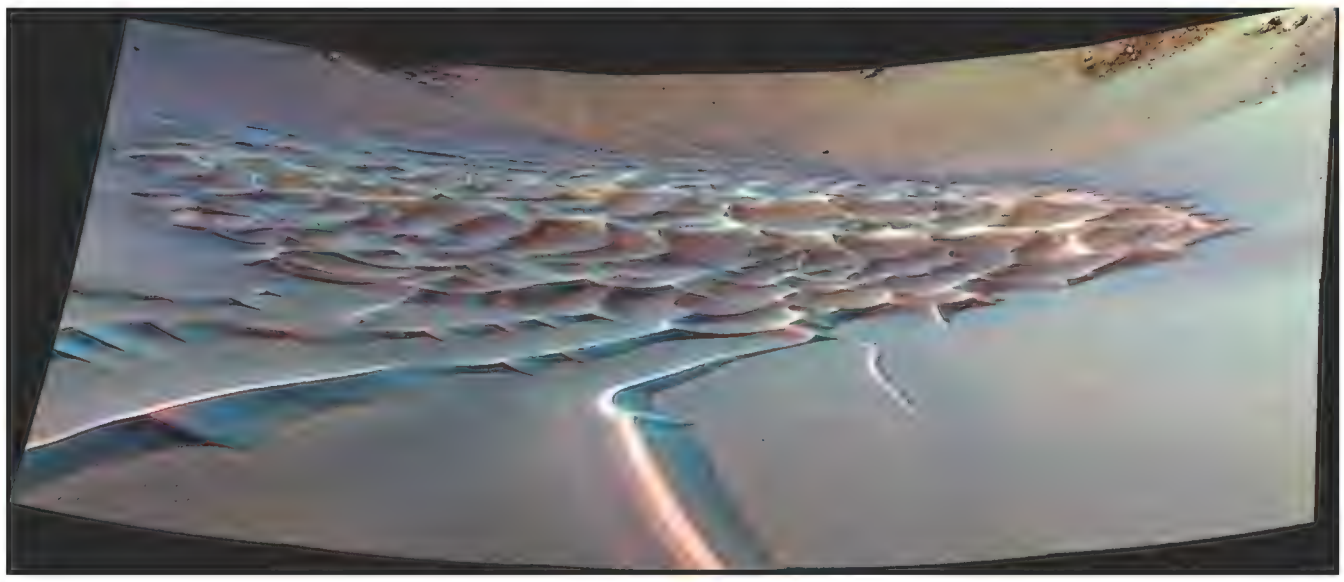
PHILIP MAKANNA/GHOSTS (2)

COURTESY PAUL BOWEN

PAUL BOWEN

160,000 Postcards and Counting

Mars has some of the loveliest landscapes in the solar system.



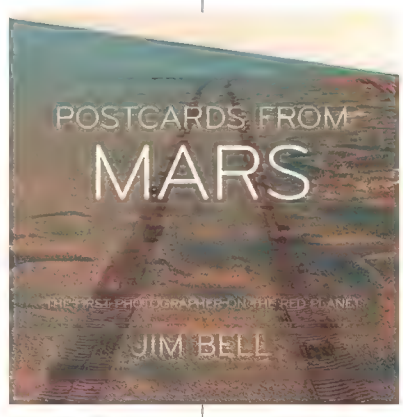
NASA/JPL/CORNELL

A panoramic camera on the rover *Opportunity* took this false-color image of sand dunes that formed along the floor of Endurance Crater.

Postcards From Mars: The First Photographer on the Red Planet

by Jim Bell. Dutton, 2006. 196 pp., $50.

RIGHT NOW, two NASA rovers are exploring the surface of Mars. Named *Spirit* and *Opportunity*, these spacecraft were designed to last only 90 days, but they have been sending back data for more than three years. To date the two rovers have traveled more than 10 miles across the Martian surface and returned more than 160,000 images. When you think about how long it took you to download the photographs from your last vacation or your kid's birthday, you have to wonder who's putting in the time needed to look at all those pictures. The answer is Cornell University professor Jim Bell, who has put together *Postcards From Mars*, a book documenting the rovers' incredible journeys.



As a scientist on the rover missions and the designer of the panoramic cameras on *Spirit* and *Opportunity*, Bell is uniquely qualified to tell their story. He has edited, processed, and cropped 150 of the most spectacular images. Here is Mars as it has never been seen before: an alien planet that is desolate but beautiful, inhospitable but inviting, mysterious but familiar. As I read the book, I found myself haunted by the words of another explorer, Charles Darwin. In his 1909 book, *The Voyage of the Beagle*, Darwin remarked, "How great would be the desire in every admirer of nature to behold, if such were possible, the scenery of another planet!" A century later, it is possible. Bell has shown us the grand results of one of the greatest research expeditions ever. Unlike most postcards, which leave you wanting to go somewhere, *Postcards From Mars* will make you feel like you've been there.

BOB CRADDOCK, A GEOLOGIST AT THE NATIONAL AIR AND SPACE MUSEUM'S CENTER FOR EARTH AND PLANETARY STUDIES, SPECIALIZES IN THE EARLY GEOLOGIC HISTORY OF MARS.

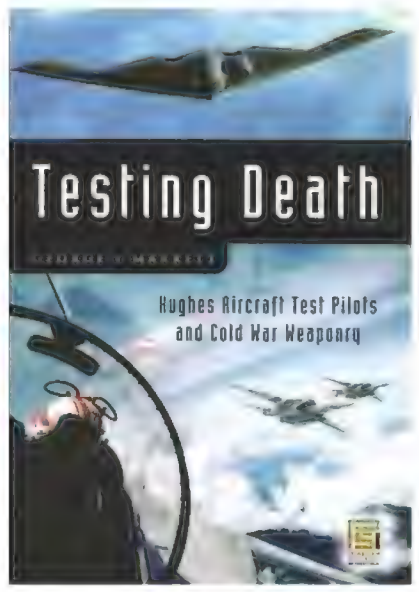
Testing Death: Hughes Aircraft Test Pilots and Cold War Weaponry

by George J. Marrett. Praeger Security International, 2006. 203 pp., $44.95.

IN *TESTING DEATH*, George Marrett vividly describes his experiences as a Hughes Aircraft Company test pilot during the 1970s and '80s, a time of cold war tensions between the Soviet Union and the United States. Through detailed recollections of his tests of air-to-air missiles (one of the cold war's lesser known but critically important technological achievements), he reveals the pilot's role in the quest for ever-greater improvements in aeronautical science and ever-deadlier weapons.

Marrett's stories are so descriptive that even those who have never flown a jet will be able to picture "strapping one on" and flying a mission: "The aircraft, held by foot brakes, strained to break free as I pushed the throttles to the firewall.... We felt the familiar *thump-thump* as the wheels retracted into the fuselage." For those who have flown high-performance jets, such detail serves to remind us of missions flown, perhaps many years ago. Although Marrett sometimes over-dramatizes his test pilot exploits, *Testing Death* does serve to highlight the importance of the scientific and technical workforce at Hughes—some 80,000 strong—who developed a variety of weapons that kept pressure on the Soviet Union.

As sure as those at Hughes contributed to cold war victory by building weapons for aerial warfare, so too did those who sat around the clock in alert shacks, missile silos, and submarines, ready to employ those weapons.



DIK A. DASO, A FORMER U.S. AIR FORCE PILOT, IS CURATOR OF MODERN MILITARY AIRCRAFT AT THE NATIONAL AIR AND SPACE MUSEUM.

>>> At a Glance <<<

Femininity in Flight: A History of Flight Attendants

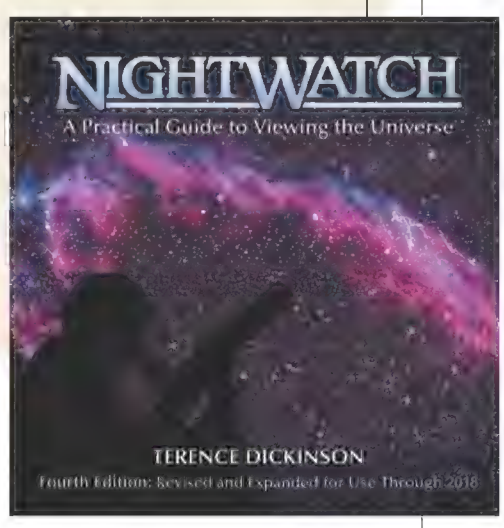
by Kathleen M. Barry. Duke University Press, 2007. 292 pp., $22.95.

THIS WELL-RESEARCHED book traces the evolution of flight attendants from glamorous sky queens to cabin safey experts and members of trade unions.

Nightwatch: A Practical Guide to Viewing the Universe

by Terence Dickinson. Firefly, 2006. 192 pp., $35.

A GUIDE FOR AMATEUR ASTRONOMERS, *Nightwatch* offers star charts that can be used through 2018, as well as detailed instructions on how to use the latest generation of digital cameras to best capture the heavens.



Front Row Center 3

by Erik Hildebrandt. Cleared Hot Media, 2007. 160 pp., $39.95.

ERIK HILDEBRANDT, an *Air & Space/Smithsonian* contributor, captures the aerial achievements of the latest airshow acts in more than 300 color photographs.

New Recipe or Classic Cub?

HOW DOES AN AIRPLANE get to be a classic? It doesn't hurt to have a marketing genius like William Piper calling the shots. In the late 1930s Piper began producing his vision of Everyman's Airplane, the J-3 Cub, decreeing that every one be painted bright yellow with a black lightning bolt emblazoned on each side. The color has since become known as "Cub yellow"; the airplane, an icon of recreational aviation.

On the road to classicdom, the right-place/right-time axiom also helps. Piper started selling the J-3 just before World War II, when the U.S. Civilian Pilot Training Program was looking for a few good, simple, sturdy, cheap airplanes to teach a countryful of farmboys and other youngsters how to fly. Piper sold almost 10,000 J-3s as trainers and, later, as olive-colored military observation and utility airplanes. First Lady Eleanor Roosevelt flew in one, as did wartime generals Dwight Eisenhower, George Patton, and George Marshall.

And then there's that logo. Who can resist a teddy bear?

But besides being recognizable and plentiful, a classic has to have something that gives it staying power. "I guess it's just one of the most fun airplanes to fly," says Kurt Sehnert, general manager of the American Legend Aircraft Company in Sulphur Springs, Texas. American

New Cub clones have the updates on the inside. Which is the American Legend Cub and which is the vintage Piper J-3?
Answer: The J-3 is on the top.

Legend is one of two companies making new Cubs—not restoring vintage J-3s or fixing up their more muscular brothers, the Piper PA-18 Super Cubs—but manufacturing new airplanes with their own Federal Aviation Administration Light Sport Aircraft type certificate.

The Cub's appeal, Sehnert says, is like that of the Volkswagen Beetle—new and old. "Was it the greatest car? Probably not," he says. But people felt so much affection for the old Beetles that Volkswagen sold a boatload of the new ones. "The Cub has a lot of romance," Sehnert says, "and it's just a good-flying airplane."

His company's Legend Cub and the Sport Cub being manufactured by Cub Crafters in Yakima, Washington, are both better fliers than the vintage version, according to pilot reviews. They don't have to be hand-propped, both come with modern instruments, and each has certain design upgrades that make it a safer, more comfortable airplane than its 70-year-old inspiration. The Legend Cub can be flown from the front or the back seat.

But while American Legend has sold 85 Legend Cubs (with orders for 20 more) and Cub Crafters has sold 80, there are still 263 vintage J-3s registered in the United States. Must be the logo.

LINDA SHINER

LEFT: COURTESY AMERICAN LEGEND AIRCRAFT COMPANY; JIM WILSON PHOTOGRAPHY; ABOVE: DON PARSONS

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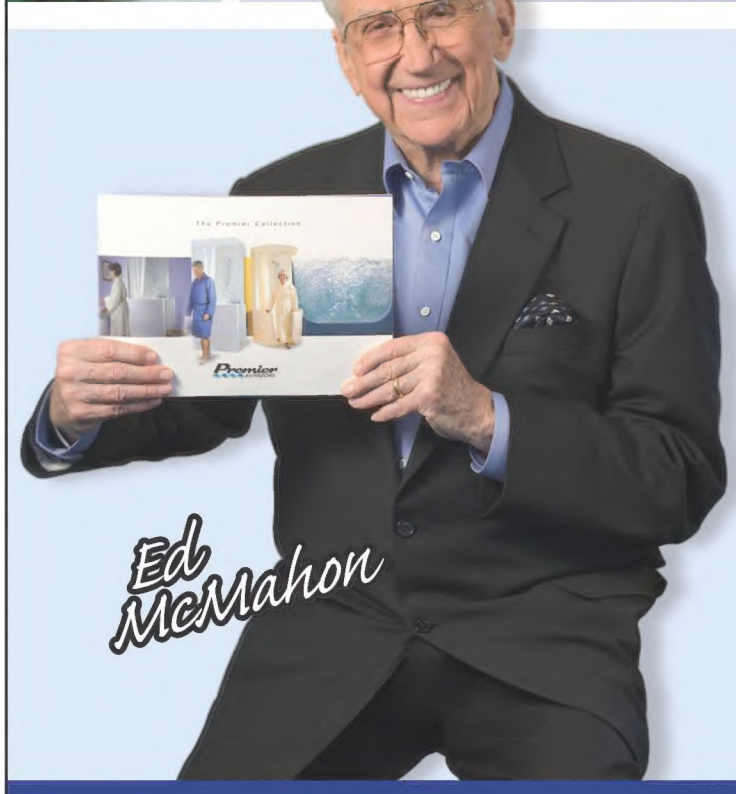

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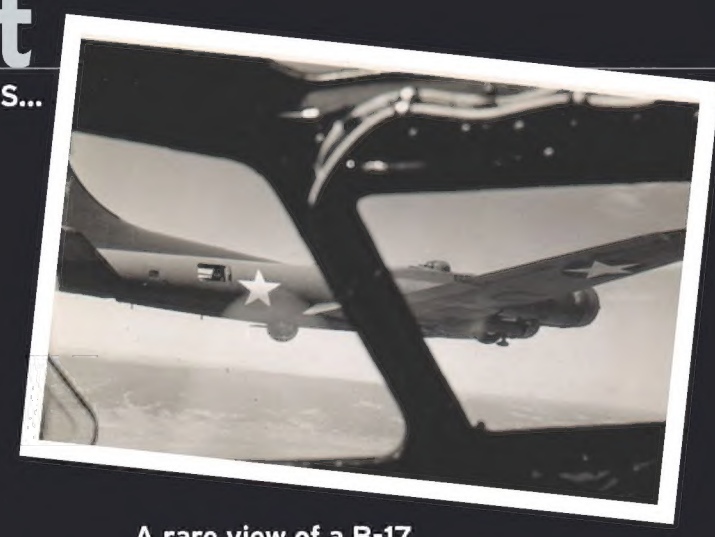

A rare view of a B-17 from the cockpit of another, this photo was handed down from father to son-in-law. Below: A Vultee Valiant transformed.

We knew it — you *do* have treasure in your attics! The *Air & Space* Reader Scrapbook is filling with historic scenes and wild airplanes. Martin Snyder of Dublin, California, found a Vultee Valiant-turned-cropduster at a 1950 airshow in Florida (below). Bruce Irving of West Boylston, Massachusetts, sent the photo of a B-17 shot by his late father-in-law, Charles H. Cook. When Cook took the picture, he was in the pilot's seat of another B-17 during a 1942 training flight over Arizona. We've already received more than 100 fascinating photographs, with subjects ranging from the earliest days of flight to an airshow last fall. (Visit *airspacemag.com* to learn more about the photos shown here and to see some photos in the collection.) We hope to get hundreds more. Do you have photographs from Vietnam or Korea? Did you find an interesting scene at a fly-in this year? Have you saved a tinted snapshot of your grandmother's first flight? Scan them, send them, and tell us why they're important to you.

Go to *www.airspacemag.com* and look for the online Reader Scrapbook icon to find out how to submit your photos for the collection.

What's in *your* attic?

LEFT: COURTESY MARTIN SNYDER; TOP: COURTESY BRUCE IRVING

SPACE AGE 50 FIFTY YEARS

IN THE NEXT ISSUE...

We All Salute the Satellite

This year is the 50th anniversary of the launch that started the Space Age. In the next issue, *Air & Space* begins a three-part celebration of Earth's first man-made satellite, Sputnik.

The Things They Find in Airplanes

At the National Air and Space Museum's historic Paul E. Garber restoration facility, restorers have pulled some very odd items from the innards of aircraft.

ERIC LONG

>>> Credits <<<

Milk Run. Chris McKenna is now an airline pilot who lives in Virginia's Shenandoah Valley.

Strategic Car Power. A passionate fan of both airplanes and race cars and a writer who has covered both, Preston Lerner wishes he could have seen – or better yet driven – a Cunningham C4R in the Strategic Air Command races of the 1950s.

Can We Stop a Nuke? Ben Iannotta is a journalist living in Summerland Key, Florida.

The Resistance. Ken Scott is a recovering potter who currently spends his time building and flying airplanes in Oregon.

Looking for Life in All the Wrong Places. Christen Brownlee is a freelance writer based in Washington, D.C.

The Moose Jaw Nine. Freelance writer Graham Chandler is a graduate of the U.S. Naval Test Pilot School. Writing from his home in Calgary, he tries to be a snowbird at least once a year.

Guide to the Great. Thrilled by airshows since the early 1970s, aerobatic pilot Debbie Gary loves writing about them.

That Extra Little Lift. Tim Wright is a Midlothian, Virginia-based freelance writer and photographer.

Fields of Dreams. Ed Regis is the author of seven science books, including the upcoming *What Is Life?*

The G Machine. Mark Wolverton's latest book is *The Depths of Space: The Story of the Pioneer Planetary Probes*.

New Recipe or Classic Cub? Linda Shiner is the editor of *Air & Space/Smithsonian*.

All for One

LOOK FOR A SPIKE in the Washington, D.C. formalwear market around early June. That's when a black-tie dinner will be held at Washington's Mellon Auditorium to award the 2006 Collier Trophy to the Lockheed Martin Corporation and the "F-22 Raptor Team." When they hand out the traditional smaller-scale duplicates of the 525-pound Collier, they'll need a good-size platform to hold the crowd, because the "Team" includes not just Lockheed but the U.S. Air Force, Boeing, Pratt & Whitney, Northrop Grumman, Raytheon, and BAE Systems.

There was a time when this most prestigious of aerospace awards went to individuals. The first one, then called the Aero Club of America Trophy, was won by Glenn Curtiss. (In 1922 the trophy was renamed for Robert J. Collier, publisher, pilot, and president of the Aero Club, who originally commissioned it.) Other pioneers whose names appear on the trophy's base include Orville Wright, Grover Loening, and Howard Hughes. Latter-day winners include such icons as Kelly Johnson, Sam Williams, and Paul MacCready (designers of the SR-71 Blackbird, the Williams turbofan, and the human-powered Gossamer Condor, for those born since Elvis died).

James Kindleberger, head of North American, and Ed Heinemann, Douglas' resident engineering genius, were also accorded the honor of being named on the trophy for the F-100 and the Skyray, respectively, partly in recognition of the fact that these men came to embody the companies they worked for. Kelly Johnson may have worked for Lockheed, but he could walk the halls of the Pentagon and greet on a first-name basis the powerful individuals who decided what the military would buy.

Collier winner: These days, it takes a village to build as complex an aircraft as the F-22 Raptor.

Men like Johnson and Kindleberger became what people refer to in modern business parlance as a "brand." If an airplane had Ed Heinemann's imprimatur on it, it was sure to outperform any competitor.

But airplanes were also simpler then. Consider that the F-22 Raptor is so stealthy as to be virtually undetectable, so fast it's supersonic without lighting its afterburner, and so wired for battle that it sees the entire local theater of operations.

On the day in February when the Collier win was announced, a dozen Raptors from Langley Air Force Base in Virginia were headed out on their first overseas deployment of 120 days.

It is the most complex fighter ever built and the most advanced, technologically speaking, that the world has ever seen. Small wonder it took a Team to put all the working pieces together.

Students of history will point out that group efforts won the trophy for three years running way back in 1922 through 1924. The U.S. Air Mail Service took it the first two of those years, for a year without a fatal crash and for night flight, while the Army was awarded the 1924 trophy for a flight around the world.

Later, the entire National Advisory Committee for Aeronautics won for developing the engine cowl that sharply reduced drag. But they were the exception that today has become the rule.

We love our heroes. Individual achievers, like star athletes, have an unquestionable appeal in this age of celebrity. But the really important things get done today by teams of people working in concert, often at great distances, linked across oceans by electronics so that the collaboration feels just as close as when the Skunk Works operated out of an unmarked shed in Burbank, California.

GEORGE C. LARSON, MEMBER, NAA

USAF, TSGT BEN BLOKER